

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

EVERYDAY

Vol.34 No.9

# PRACTICAL ELECTRONICS

CAN \$6.99/US \$4.95

## SNOOKER & DARTS SCOREBOARD

PIC-based electronic aid and display



## MULTICORE CABLE TESTER

Automatic testing for a wide range of cables

## ALL-BAND RADIO

Simple set covering the long wave to 41m bands

■■■■ PLUS

## BACK TO BASICS - 6

Daily Reminder  
Whistle Switch



www.epemag.co.uk

**Copyright © 2005, Wimborne Publishing Ltd**  
**(408 Wimborne Road East, Ferndown, Dorset, BH22 9ND, UK)**

**and TechBites Interactive Inc.,**  
**(PO Box 857, Madison, Alabama 35758, USA)**

**All rights reserved.**

## ***WARNING!***

The materials and works contained within *EPE Online* — which are made available by Wimborne Publishing Ltd and TechBites Interactive Inc — are copyrighted. You are permitted to make a backup copy of the downloaded file and one (1) hard copy of such materials and works for your personal use. International copyright laws, however, prohibit any further copying or reproduction of such materials and works, or any republication of any kind.

TechBites Interactive Inc and Wimborne Publishing Ltd have used their best efforts in preparing these materials and works. However, TechBites Interactive Inc and Wimborne Publishing Ltd make no warranties of any kind, expressed or implied, with regard to the documentation or data contained herein, and specifically disclaim, without limitation, any implied warranties of merchantability and fitness for a particular purpose.

Because of possible variances in the quality and condition of materials and workmanship used by readers, *EPE Online*, its publishers and agents disclaim any responsibility for the safe and proper functioning of reader-constructed projects based on or from information published in these materials and works. In no event shall TechBites Interactive Inc or Wimborne Publishing Ltd be responsible or liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or any other damages in connection with or arising out of furnishing, performance, or use of these materials and works.



ISSN 0262 3617

PROJECTS ... THEORY ... NEWS ...  
COMMENTS ... POPULAR FEATURES ...

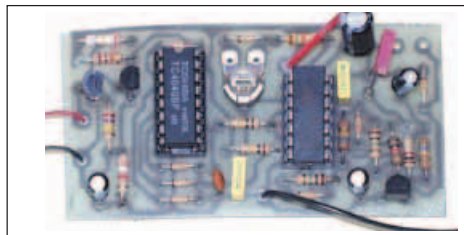
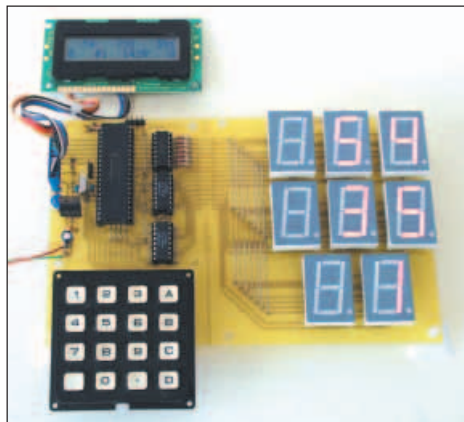
**VOL. 34. No. 9 SEPTEMBER 2005**

Cover illustration: Mehau Kulyk/Science Photo Library

# EVERYDAY PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS TODAY INTERNATIONAL

[www.epemag.co.uk](http://www.epemag.co.uk)  
**EPE Online: [www.epemag.com](http://www.epemag.com)**



© Wimborne Publishing Ltd 2005. Copyright in all drawings, photographs and articles published in **EVERYDAY PRACTICAL ELECTRONICS** is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Our October 2005 issue will be published on Thursday, 8 September 2005. See page 595 for details

## Projects and Circuits

- ALL-BAND RADIO** by Thomas Scarborough **604**  
No-frills, low-budget, easy-build, sensitive radio with excellent reception
- MULTICORE CABLE TESTER** by Mike Geary **612**  
How to conveniently check lengthy multicore cables
- INGENUITY UNLIMITED – Sharing your ideas with others** **618**  
Low-cost RS232 Interface; TV Audio Coupler; PIC-Based Noise Generator
- SNOOKER AND DARTS SCOREBOARD** by John Becker **626**  
Readily display all the scores at your snooker and darts matches
- CONTROLLING MODEL RAILWAY SIGNALS** by John Waller **636**  
Using stepper motors to control the semaphore signals used with model railways
- BACK TO BASICS – 6 Daily Reminder and Whistle Switch** by Bart Trepak **648**  
Simple, easy-to-build circuits based on one or two CMOS logic chips

## Series and Features

- TECHNO TALK** by Mark Nelson **620**  
Describing the problems of wind turbines – and some ingenious solutions
- CIRCUIT SURGERY** by Alan Winstanley and Ian Bell **622**  
Low-frequency amplification, plus simple low-battery monitoring
- PRACTICALLY SPEAKING** by Robert Penfold **634**  
A novice's guide to measurement units
- PIC N' MIX** by John Becker **658**  
Getting a DS1267 dual digital potentiometer working with a PIC
- NET WORK – THE INTERNET PAGE** surfed by Alan Winstanley **660**  
Emails and ISPs

## Regulars and Services

- EDITORIAL** **603**
- NEWS** – Barry Fox highlights technology's leading edge **610**  
Plus everyday news from the world of electronics
- SHOPTALK** with David Barrington **624**  
The *essential* guide to component buying for *EPE* projects
- READOUT** John Becker addresses general points arising **642**
- CD-ROMS FOR ELECTRONICS** **645**  
A wide range of CD-ROMs for hobbyists, students and engineers
- DIRECT BOOK SERVICE** **655**  
A wide range of technical books available by mail order, plus more CD-ROMs
- PRINTED CIRCUIT BOARD AND SOFTWARE SERVICE** **661**  
PCBs for *EPE* projects. Plus *EPE* project software
- BACK ISSUES** Did you miss these? **662**
- ADVERTISERS INDEX** **664**

**Readers Services • Editorial and Advertisement Departments 603**

# NEXT MONTH

## PIC-BASED USB INTERFACE

Are you ready to jump on the Universal Serial Bus (USB) bandwagon? Maybe you have an existing embedded application or a PIC design you would like to update or develop to use USB. In this article we explore the basics of an easy way of getting data into and out of a PIC18F2455 microcontroller using its USB interface.

This design allows existing RS232 devices to be controlled by a Windows 2000/XP USB connection. Although the design is simple, it illustrates the process of getting data into and out of the PIC over a USB connection. The "easy way" approach to USB makes maximum use of existing free software and Windows drivers.

## PHOTIC PHONE

The Photic Phone slices up the human voice into forty-thousand binary segments a second, transmits it over a light-beam, then re-integrates it at the other side. That is, it applies pulse width modulation (p.w.m.) to the voice, to create a binary transmission. This has the advantage of always transmitting at full intensity, meaning that even the weakest nuances of a voice will reach the receiver as strongly as the rest.

The circuit typically has a range five times greater than similar analogue circuits. Without the use of lenses, the prototype achieved a range of four metres. With a single lens at the transmitter, it achieved a range of fifteen metres. With the use of two lenses, it should achieve a range of fifty metres using a single cheap, ultrabright l.e.d. It is all but impossible for anyone to eavesdrop on a transmission.

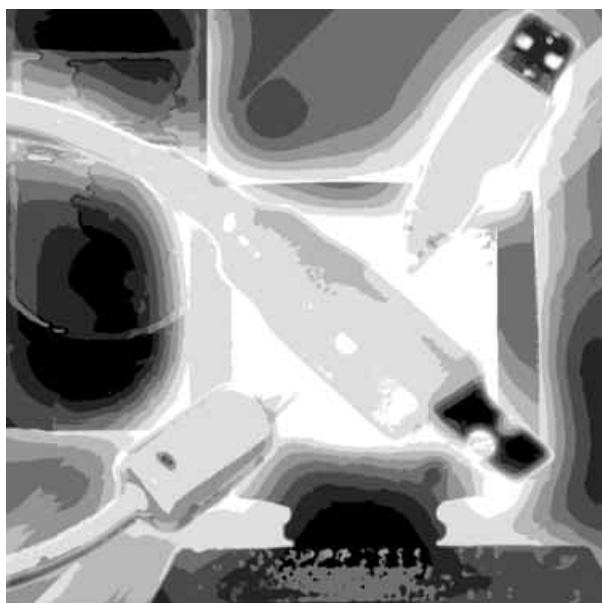
## PLUS BACK TO BASICS – 7

### ● Parking Radar

Avoid expensive mishaps to that car behind you.

### ● Telephone Switch

Phone home and remotely control an electric appliance while you're away.



## HALLOWEEN HOWLER

Halloween's coming – why not give your "trick or treat" visitors a scare?! Picture a pumpkin head, eyes lighting up red and emitting an eerie howl when someone walks past it!

Although intended to help generate a bit of fun over Halloween this project also serves to demonstrate just how easy (and cheap) it can be to output audio in an electronics project. The sound comes from a pre recorded computer "WAV" file stored in a small EEPROM memory. WAV files can be downloaded from the internet, extracted from music CDs and even recorded by yourself on a PC using software supplied with most operating systems.

The circuit described can be configured into one of two modes of operation: Halloween Howler, which includes a light sensor to detect moving objects, and a generic 3-input design that allows one of three stored sound samples to be played when an input is asserted. This second setup provides a more general purpose sound generator that can have a number of uses.

# NO ONE DOES IT BETTER



**DON'T MISS AN  
ISSUE – PLACE YOUR  
ORDER NOW!**

see page 640

Or take out a subscription and save money.

see page 598

**OCTOBER 2005 ISSUE ON SALE THURSDAY, SEPTEMBER 8**



**QUASAR**  
electronics

Helping you make the right connections!

**Quasar Electronics Limited**  
PO Box 6935, Bishops Cleeve, Stortford,  
CM23 4WP  
Tel: 0870 246 1826  
Fax: 0870 460 1045  
E-mail: sales@quasarelectronics.com

**Postage & Packing Options** (Up to 2kg gross weight): **UK standard 3-7 Day Delivery** – £3.95; **UK Mainland Next Day Delivery** – £8.95; **Europe (EU)** – £6.95; **Rest of World** – £9.95 **!Order online for reduced price UK Postage!**  
We accept all major credit/debit cards. Make cheques/POs payable to Quasar Electronics Limited.  
Prices include 17.5% VAT. **MAIL ORDER ONLY.**  
Call now for our **FREE CATALOGUE** with details of over 300 high quality kits, projects, modules and publications.



**0871 CREDIT CARD SALES 717 7168**

## PIC & ATMEL Programmers

We have a wide range of low cost PIC and ATMEL Programmers. Complete range and documentation available from our web site.

### Programmer Accessories:

**40-pin Wide ZIF socket (ZIF40W) £15.00**

**18VDC Power supply (PSU010) £19.95**

**Leads: Parallel (LDC136) £4.95 / Serial (LDC441) £4.95 / USB (LDC644) £2.95**

### NEW! USB 'Flash' PIC Programmer

USB PIC programmer for most 'Flash' devices. No external power supply makes it truly portable. Supplied with box and Windows Software. ZIF Socket and USB Plug A-B lead not incl.

Kit Order Code: 3128KT – **£34.95**

Assembled Order Code: AS3128 – **£39.95**



### "PICALL" ISP PIC Programmer

"PICALL" will program virtually all 8 to 40 pin serial-mode\* and parallel-mode (PIC16C5x family)\* Programmed PIC micro controllers. Free fully functional

software. Blank chip auto detect for super fast bulk programming. Parallel port connection. Supply: 16-18V dc.

Assembled Order Code: AS3117 – **£39.95**

### ATMEL 89xxx Programmer

Uses serial port and any standard terminal comms program. 4 LEDs display the status. ZIF sockets not included. Supply: 16VDC.

Kit Order Code: 3123KT – **£29.95**



### NEW! USB & Serial Port PIC Programmer

USB/Serial connection. Header cable for ICSP. Free Windows software. See website for PICs supported. ZIF Socket and USB Plug A-B lead extra. 18VDC.

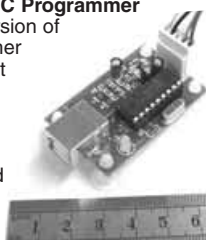
Kit Order Code: 3149KT – **£34.95**

Assembled Order Code: AS3149 – **£49.95**

### USB Flash ICSP PIC Programmer

Fully assembled version of our 3128 USB Flasher PIC Programmer but WITHOUT the pre-programming socket. It just has 5-pin ICSP header (GND, VCC, CLK, DAT, VPP) and cable. No external PSU required. Free Windows software.

Order Code: AS3182 – **£37.95**



### ABC Maxi AVR Development Board

The ABC Maxi board has an open architecture design based on Atmel's AVR AT90S8535 RISC microcontroller and is ideal for developing new designs.

#### Features:

- 8Kb of In-System Programmable Flash (1000 write/erase cycles) • 512 bytes internal SRAM • 512 bytes EEPROM
- 8 analogue inputs (range 0-5V)
- 4 Opto-isolated Inputs (I/Os are bi-directional with internal pull-up resistors)
- Output buffers can sink 20mA current (direct I.e.d. drive) • 4 x 12A open drain MOSFET outputs • RS485 network connector • 2-16 LCD Connector
- 3-5mm Speaker Phone Jack
- Supply: 9-12VDC.

The ABC Maxi STARTER PACK includes one assembled Maxi Board, parallel and serial cables, and Windows software CD-ROM featuring an Assembler, BASIC compiler and in-system programmer.

Order Code ABCMAXISP – **£89.95**

*The ABC Maxi boards only can also be purchased separately at £69.95 each.*



## Controllers & Loggers

Here are just a few of the controller and data acquisition and control units we have. See website for full details. Suitable PSU for all units: Order Code PSU445 – **£8.95**

### Rolling Code 4-Channel UHF Remote

State-of-the-Art. High security.

4 channels. Momentary or latching relay output. Range up to 40m. Up to 15 TXs can be learned by one Rx (kit includes one Tx but more available separately).

4 indicator LEDs.

Rx: PCB 77x85mm, 12VDC/6mA (standby).

*Two & Ten Channel versions also available.*

Kit Order Code: 3180KIT – **£39.95**

Assembled Order Code: AS3180 – **£47.95**



### Computer Temperature Data Logger

Serial port 4-channel temperature logger. °C or °F. Continuously logs up to 4 separate sensors located 200m+ from board. Wide range of free software applications for storing/using data. PCB just 38x38mm. Powered by PC. Includes one DS1820 sensor and four header cables.

Kit Order Code: 3145KT – **£16.95**

Assembled Order Code: AS3145 – **£23.95**

Additional DS1820 Sensors – **£3.95 each**



**Most items are available in kit form (KT suffix) or pre-assembled and ready for use (AS prefix).**

### NEW! DTMF Telephone Relay Switcher

Call your phone number using a DTMF phone from anywhere in the world and remotely turn on/off any of the 4 relays as desired. User settable Security Password, Anti-Tamper, Rings to Answer, Auto Hang-up and Lockout. Includes plastic case. 130 x 110 x 30mm. Power: 12VDC.

Kit Order Code: 3140KT – **£39.95**

Assembled Order Code: AS3140 – **£59.95**



### Serial Port Isolated I/O Module



Computer controlled 8-channel relay board. 5A mains rated relay outputs and 4 opto-isolated digital inputs (for monitoring switch

states, etc). Useful in a variety of control and sensing applications. Programmed via serial port (use our new Windows interface, terminal emulator or batch files). Serial cable can be up to 35m long. Includes plastic case 130 x 100 x 30mm. Power: 12VDC/500mA.

Kit Order Code: 3108KT – **£49.95**

Assembled Order Code: AS3108 – **£59.95**

### Infra-red RC 12-Channel Relay Board



Control 12 on-board relays with included infra-red remote control unit. Toggle or momentary. 15m+ range. 112 x 122mm.

Supply: 12VDC/0.5A.

Kit Order Code: 3142KT – **£39.95**

Assembled Order Code: AS3142 – **£49.95**

### PC Data Acquisition & Control Unit

Monitor and log a mixture of analogue and digital inputs and control external devices via the analogue and digital outputs. Monitor pressure, temperature, light intensity, weight, switch state, movement, relays, etc. with the appropriate sensors (not supplied). Data can be processed, stored and the results used to control devices such as motors, sirens, relays, servo motors (up to 11) and two stepper motors.



#### Features

- 11 Analogue Inputs – 0-5V, 10 bit (5mV/step)
- 16 Digital Inputs – 20V max. Protection 1K in series, 5-1V Zener
- 1 Analogue Output – 0-2.5V or 0-10V. 8 bit (20mV/step)
- 8 Digital Outputs – Open collector, 500mA, 33V max
- Custom box (140 x 110 x 35mm) with printed front & rear panels
- Windows software utilities (3-1 to XP) and programming examples
- Supply: 12V DC (Order Code PSU203)

Kit Order Code: 3093KT – **£64.95**

Assembled Order Code: AS3093 – **£94.95**



## Hot New Kits This Summer!

Here are a few of the most recent kits added to our range. See website or join our email Newsletter for all the latest news.

### NEW! EPE Ultrasonic Wind Speed Meter



Solid-state design wind speed meter (anemometer) that uses ultrasonic techniques and has no moving parts and does not need

calibrating. It is intended for sports-type activities, such as track events, sailing, hang-gliding, kites and model aircraft flying, to name but a few. It can even be used to monitor conditions in your garden. The probe is pointed in the direction from which the wind is blowing and the speed is displayed on an LCD display.

#### Specifications

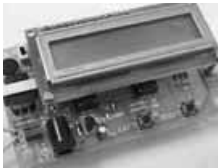
- Units of display: metres per second, feet per second, kilometres per hour and miles per hour
- Resolution: Nearest tenth of a metre
- Range: Zero to 50mph approx.

Based on the project published in Everyday Practical Electronics, Jan 2003. We have made a few minor design changes (see web site for full details). Power: 9VDC (PP3 battery or Order Code PSU345).

Main PCB: 50 x 83mm.

Kit Order Code: 3168KT – £34.95

### NEW! Audio DTMF Decoder and Display



Detects DTMF tones via an on-board electret microphone or direct from the phone lines through the onboard audio transformer. The

numbers are displayed on a 16-character, single line display as they are received. Up to 32 numbers can be displayed by scrolling the display left and right. There is also a serial output for sending the detected tones to a PC via the serial port. The unit will not detect numbers dialled using pulse dialling. Circuit is microcontroller based.

Supply: 9-12V DC (Order Code PSU345). Main PCB: 55 x 95mm.

Kit Order Code: 3153KT – £17.95

Assembled Order Code: AS3153 – £29.95

### NEW! EPE PIC Controlled LED Flasher



This versatile PIC-based LED or filament bulb flasher can be used to flash

from 1 to 160 LEDs. The user arranges the LEDs in any pattern they wish. The kit comes with 8 superbright red LEDs and 8 green LEDs. Based on the Versatile PIC Flasher by Steve Challinor, EPE Magazine Dec '02. See website for full details. Board Supply: 9-12V DC. LED supply: 9-45V DC (depending on number of LED used). PCB: 43 x 54mm.

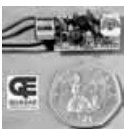
Kit Order Code: 3169KT – £11.95

Most items are available in kit form (KT suffix) or assembled and ready for use (AS prefix)

## FM Bugs & Transmitters

Our extensive range goes from discreet surveillance bugs to powerful FM broadcast transmitters. Here are a few examples. All can be received on a standard FM radio and have adjustable transmitting frequency.

### MMTX' Micro-Miniature 9V FM Room Bug



Our best selling bug! Good performance. Just 25 x 15mm. Sold to detective agencies worldwide. Small enough to hide just about anywhere.

Operates at the 'less busy' top

end of the commercial FM waveband and also up into the more private Air band.

Range: 500m. Supply: PP3 battery.

Kit Order Code: 3051KT – £8.95

Assembled Order Code: AS3051 – £14.95

### HPTX' High Power FM Room Bug

Our most powerful room bug.

Very Impressive

performance. Clear and stable output signal thanks to the extra circuitry employed.

Range: 1000m @ 9V. Supply: 6-12V DC (9V PP3 battery clip supplied). 70 x 15mm.

Kit Order Code: 3032KT – £9.95

Assembled Order Code: AS3032 – £17.95

### MTTX' Miniature Telephone Transmitter



Attach anywhere along phone line.

Tune a radio into the signal and hear

exactly what both parties are saying.

Transmits only when phone is used. Clear, stable signal. Powered from phone line so completely maintenance free once installed. Requires no aerial wire – uses phone line as antenna. Suitable for any phone system worldwide. Range: 300m. 20 x 45mm.

Kit Order Code: 3016KT – £7.95

Assembled Order Code: AS3016 – £13.95

### 3 Watt FM Transmitter



Small, powerful FM transmitter. Audio preamp stage and three RF stages deliver 3 watts of RF power. Can be used with the electret

microphone supplied or any line level audio source (e.g. CD or tape OUT, mixer, sound card, etc). Aerial can be an open dipole or Ground Plane. Ideal project for the novice wishing to get started in the fascinating world of FM broadcasting. 45 x 145mm.

Kit Order Code: 1028KT – £23.95

Assembled Order Code: AS1028 – £31.95

### 25 Watt FM Transmitter

Four transistor based stages with a Philips BLY89 (or equivalent) in the final stage. Delivers a mighty 25 Watts of RF power. Accepts any line level audio source (input sensitivity is adjustable). Antenna can be an open dipole, ground plane, 5/8, J, or YAGI configuration. Supply 12-14V DC, 5A. Supplied fully assembled and aligned – just connect the aerial, power and audio input. 70 x 220mm.

Order Code: AS1031 – £134.95



Helping you make the right connections!

**CREDIT  
CARD  
SALES**  
**0871  
717  
7168**

## Electronic Project Labs

Great introduction to the world of electronics. Ideal gift for budding electronics expert!

### 500-in-1 Electronic Project Lab

This is the top of the range and is a complete electronics course taking you from beginner to 'A' level standard and beyond! It contains all the parts and instructions to assemble 500 projects. You get three comprehensive course books (total 368 pages) – *Hardware Entry Course*, *Hardware Advanced Course* and a micro-computer based *Software Programming Course*. Each book has individual circuit explanations, schematic and assembly diagrams. Suitable for age 12 and above.

Order Code EPL500 – £149.95

30, 130, 200 and 300-in-1 project labs also available – see website for details.

## Number 1 for Kits!

With over 300 projects in our range we are the UK's number 1 electronic kit specialist. Here are a few other kits from our range.

- 1046KT – 25W Stereo Car Booster £29.95
- 3087KT – 1W Stereo Amplifier £6.95
- 3105KT – 18W BTL mono Amplifier £9.95
- 3106KT – 50W Mono Hi-fi Amplifier £23.95
- 3143KT – 10W Stereo Amplifier £10.95
- 1011-12KT – Motorbike Alarm £12.95
- 1019KT – Car Alarm System £12.95
- 1048KT – Electronic Thermostat £9.95
- 1080KT – Liquid Level Sensor £6.95
- 3003KT – LED Dice £7.95
- 3006KT – LED Roulette Wheel £9.95
- 3074KT – 8-Ch PC Relay Board £24.95
- 3082KT – 2-Ch UHF Relay £30.95
- 3126KT – Sound-Activated Relay £8.95
- 3063KT – One Chip AM Radio £11.95
- 3102KT – 4-Ch Servo Motor Driver £15.95
- 3155KT – Stereo Tone Controls £11.95
- 1096KT – 3-30V, 5A Stabilised PSU £32.95
- 3029KT – Combination Lock £7.95
- 3049KT – Ultrasonic Detector £14.95
- 3130KT – Infra-red Security Beam £13.95
- SG01MKT – Train Sounds £6.95
- SG10 MKT – Animal Sounds £5.95
- 1131KT – Robot Voice Effect £9.95
- 3007KT – 3V FM Room Bug £6.95
- 3028KT – Voice-Activated FM Bug £11.95
- 3033KT – Telephone Recording Adpt £8.95
- 3112KT – PC Data Logger/Sampler £18.95
- 3118KT – 12-bit Data Acquisition Unit £49.95
- 3101KT – 20MHz Function Generator £69.95

**No.1  
FOR  
KITS**

**www.quasarelectronics.com**

Secure Online Ordering Facilities ● Full Product Listing, Descriptions & Photos ● Kit Documentation & Software Downloads



UK readers you can  
**SAVE 71p**  
on every issue of *EPE*

How would you like to pay £2.58 instead of £3.30 for your copy of *EPE*?  
Well you can – just take out a one year subscription and save over 71p an issue,  
or £8.60 over the year

You can even **save over 92p an issue** if you subscribe for two years  
– a total saving of £22.20

Overseas rates also represent exceptional value

You also:

- Avoid any cover price increase for the duration of your subscription
- Get your magazine delivered to your door each month
- Ensure your copy, even if the newsagents sell out

Order by phone or fax with a credit card or by post with a cheque or postal order, or  
buy on-line from [www.epemag.co.uk](http://www.epemag.co.uk) (click on “Subscribe Now”)



### EPE SUBSCRIPTION PRICES

Subscriptions for delivery direct to any address in the UK:  
6 months £16.50, 12 months £31, two years £57; Overseas:  
6 months £19.50 standard air service or £28.50 express airmail,  
12 months £37 standard air service or £55 express airmail,  
24 months £69 standard air service or £105 express airmail.  
Cheques or bank drafts (in **£ sterling only**) payable to *Everyday Practical Electronics* and sent to *EPE Subs. Dept.*, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872. Fax: 01202 874562. Email: [subs@epemag.wimborne.co.uk](mailto:subs@epemag.wimborne.co.uk). Also via the **Web** at <http://www.epemag.co.uk>. Subscriptions start with the next available issue. We accept MasterCard, Amex, Diners Club, Maestro or Visa. (For past issues see the *Back Issues* page.)

### ONLINE SUBSCRIPTIONS

Online subscriptions, for downloading the magazine via the Internet, \$14.99US (approx. £8) for one year available from [www.epemag.com](http://www.epemag.com).

### USA/CANADA SUBSCRIPTIONS

To subscribe to *EPE* from the USA or Canada please telephone Express Mag toll free on 1877 363-1310 and have your credit card details ready. Or fax (514) 355 3332 or write to Express Mag, PO Box 2769, Plattsburgh, NY 12901-0239 or Express Mag, 8155 Larrey Street, Anjou, Quebec, H1J 2L5.  
Email address: [expmag@expressmag.com](mailto:expmag@expressmag.com).

Web site: [www.expressmag.com](http://www.expressmag.com).

USA price \$60(US) per annum, Canada price \$97(Can) per annum – 12 issues per year.

*Everyday Practical Electronics*, periodicals pending, ISSN 0262 3617 is published twelve times a year by Wimborne Publishing Ltd., USA agent USACAN at 1320 Route 9, Champlain, NY 12919. Subscription price in US \$60(US) per annum. Periodicals postage paid at Champlain NY and at additional mailing offices. POSTMASTER: Send USA and Canada address changes to *Everyday Practical Electronics*, c/o Express Mag., PO Box 2769, Plattsburgh, NY, USA 12901-0239.

### SUBSCRIPTION ORDER FORM

- ☐ 6 Months: UK £16.50, Overseas £19.50 (standard air service), £28.50 (express airmail)
- ☐ 1 Year: UK £31.00, Overseas £37.00 (standard air service) £55 (express airmail)
- ☐ 2 Years: UK £57.00, Overseas £69.00 (standard air service) £105 (express airmail)
- To: *Everyday Practical Electronics*,  
Wimborne Publishing Ltd., 408 Wimborne Road East,  
Ferndown, Dorset BH22 9ND  
Tel: 01202 873872 Fax: 01202 874562  
E-mail: [subs@epemag.wimborne.co.uk](mailto:subs@epemag.wimborne.co.uk)

I enclose payment of £ ..... (cheque/PO in £ sterling only), payable to *Everyday Practical Electronics*

My card number is: .....  
Please print clearly, and check that you have the number correct

Signature .....

Card Security Code ..... (The last 3 digits on or just under the signature strip)

Card Ex. Date ..... Maestro Issue No. ....

Name .....

Address .....

Post code ..... Tel. ....

**Subscriptions can only start with the next available issue.**

## MAIL ORDER ONLY • CALLERS BY APPOINTMENT

### EPE PROJECT PICS

#### Programmed PICs for \*EPE Projects

12C508/9 - £3.90; 16F627/8 - £4.90

16C84/16F84/16C71 - £5.90

16F876/877 - £10.00

All inc. VAT and Postage

(\*Some projects are copyright)

### EPE MICROCONTROLLER P.I. TREASURE HUNTER

The latest MAGENTA DESIGN - highly stable & sensitive - with I.C. control of all timing functions and advanced pulse separation techniques.

- High stability drift cancelling
- Easy to build & use
- No ground effect, works in seawater



- Detects gold, silver, ferrous & non-ferrous metals

- Efficient quartz controlled microcontroller pulse generation.
- Full kit with headphones & all hardware

**KIT 847 ..... £63.95**

### PIC PIPE DESCALER

- SIMPLE TO BUILD
- HIGH POWER OUTPUT
- AUDIO & VISUAL MONITORING
- SWEPT FREQUENCY

An affordable circuit which sweeps the incoming water supply with variable frequency electromagnetic signals. May reduce scale formation, dissolve existing scale and improve lathering ability by altering the way salts in the water behave.

Kit includes case, P.C.B., coupling coil and all components. High coil current ensures maximum effect. L.E.D. monitor.

**KIT 868 ..... £22.95**

**POWER UNIT.....£3.99**



### MICRO PEST SCARER

Our latest design - The ultimate scarer for the garden. Uses special microchip to give random delay and pulse time. Easy to build reliable circuit. Keeps pets/pests away from newly sown areas, play areas, etc. uses power source from 9 to 24 volts.

- RANDOM PULSES
- HIGH POWER
- DUAL OPTION

Plug-in power supply £4.99

**KIT 867. .... £19.99**

**KIT + SLAVE UNIT. .... £32.50**



### WINDICATOR

A novel wind speed indicator with LED readout. Kit comes complete with sensor cups, and weatherproof sensing head. Mains power unit £5.99 extra.

**KIT 856. .... £28.00**

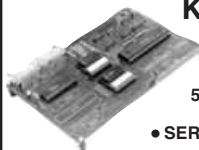
### 68000 DEVELOPMENT TRAINING KIT

- NEW PCB DESIGN
- 8MHz 68000 16-BIT BUS
- MANUAL AND SOFTWARE
- 2 SERIAL PORTS
- PIT AND I/O PORT OPTIONS
- 12C PORT OPTIONS

**KIT 621**

**£99.95**

- ON BOARD 5V REGULATOR
- PSU £6.99
- SERIAL LEAD £3.99



### Stepping Motors

MD100...Std 100 step...£9.99

MD200...200 step...£12.99

MD24...Large 200 step...£22.95



### MOSFET MKII VARIABLE BENCH POWER SUPPLY 0-25V 2.5A

Based on our Mk1 design and preserving all the features, but now with switching pre-regulator for much higher efficiency. Panel meters indicate Volts and Amps. Fully variable down to zero. Toroidal mains transformer. Kit includes punched and printed case and all parts. As featured in April 1994 EPE. An essential piece of equipment.



Kit No. 845 ..... £64.95

### ULTRASONIC PEST SCARER

Keep pets/pests away from newly sown areas, fruit, vegetable and flower beds, children's play areas, patios etc. This project produces intense pulses of ultrasound which deter visiting animals.

- KIT INCLUDES ALL COMPONENTS, PCB & CASE
- EFFICIENT 100V TRANSDUCER OUTPUT
- COMPLETELY INAUDIBLE TO HUMANS



- UP TO 4 METRES RANGE
- LOW CURRENT DRAIN

**KIT 812. .... £15.00**

## EPE TEACH-IN 2000

Full set of top quality NEW components for this educational series. All parts as specified by EPE. Kit includes breadboard, wire, croc clips, pins and all components for experiments, as listed in introduction to Part 1.

\*Batteries and tools not included.

**TEACH-IN 2000 -**

**KIT 879 £44.95**

**MULTIMETER £14.45**

### SPACEWRITER

An innovative and exciting project. Wave the wand through the air and your message appears. Programmable to hold any message up to 16 digits long. Comes pre-loaded with "MERRY XMAS". Kit includes PCB, all components & tube plus instructions for message loading.

**KIT 849 ..... £16.99**



### 12V EPROM ERASER

A safe low cost eraser for up to 4 EPROMS at a time in less than 20 minutes. Operates from a 12V supply (400mA). Used extensively for mobile work - updating equipment in the field etc. Also in educational situations where mains supplies are not allowed. Safety interlock prevents contact with UV.

**KIT 790 ..... £29.90**

### SUPER BAT DETECTOR

1 WATT O/P, BUILT IN  
SPEAKER, COMPACT CASE  
20kHz-140kHz  
NEW DESIGN WITH 40kHz MIC.

A new circuit using a 'full-bridge' audio amplifier i.c., internal speaker, and headphone/tape socket. The latest sensitive transducer, and 'double balanced mixer' give a stable, high performance superheterodyne design.



**KIT 861 ..... £34.99**

ALSO AVAILABLE Built & Tested... £48.99

### SIMPLE PIC PROGRAMMER

**KIT 857... £12.99**

Includes PIC16F84 chip disk, lead, plug, p.c.b., all components and instructions

Extra 16F84 chips £3.84  
Power Supply £3.99



## PIC LCD DISPLAY DRIVER

16 Character x 2 Line display, pcb, programmed PIC16F84, software disk and all components to experiment with standard intelligent alphanumeric displays. Includes full PIC source code which can be changed to match your application.

**KIT 860.....£19.99**

- Learn how to drive the display and write your own code.
- Ideal development base for meters, calculators, counters, timers --- just waiting for your application!
- **Top quality display** with industry standard driver, data and instructions

## PIC STEPPING MOTOR DRIVER

PCB with components and PIC16F84 programmed with demonstration software to drive any 4 phase unipolar motor up to 24 Volts at 1 Amp. **Kit includes 100 Step Hybrid Stepping Motor.** Full software source code supplied on disc.

Use this project to develop your own applications. PCB allows 'simple PIC programmer' 'SEND' software to be used to reprogram chip.

**KIT 863.....£18.99**

## 8 CHANNEL DATA LOGGER

From Aug/Sept.'99 *EPE*. Featuring 8 analogue inputs and serial data transfer to PC. Magenta redesigned PCB - LCD plugs directly onto board. Use as Data Logger or as a test bed for developing other PIC16F877 projects. Kit includes lcd, prog'd. chip, PCB, Case, all parts and 8 x 256k EEPROMs

**KIT 877.....£49.95**

## PIC16F84 MAINS POWER CONTROLLER & 4 CHANNEL LIGHT CHASER / DIMMER

- Zero Volt Switching
- Opto-Isolated 5 Amp **HARD FIRED TRIACS**
- 12 Way keypad Control

- With program source code disk.
- Chase Speed and dimming potentiometer controls.
- Reprogram for other applications

**KIT 855.....£39.95**

## PIC TUTOR 1 EPE MARCH APRIL MAY '98 PIC16F84 STARTER SERIES

The original PIC16F84 series by John Becker. Magenta's Tutor board has individual switches and leds on all portA and PortB lines, plus connectors for optional 4 digit seven segment led display, and 16 x 2 intelligent lcd. Written for newcomers to PICs this series. Disk has over 20 tutorial programs. Connect to a PC parallel port, send, run, and experiment by modifying test programs - Then Write and Program your Own

**KIT 870... £27.95, Built...£42.95**

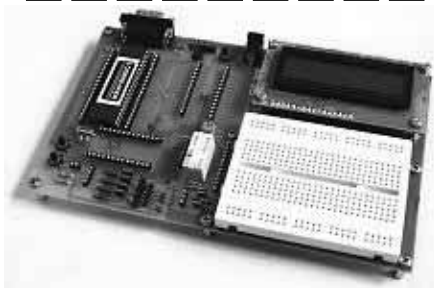
16x2 LCD..£7.99. LED display..£6.99. 12VPSU..£3.99

## SUPER PIC PROGRAMMER

Magenta's original parallel port programmer. Runs with downloaded WINDOWS 95 - XP software. Use standard Microchip .HEX files. Read/Prog/Verify wide range of 18,28, and 40 pin PICs. Including 16F84/876/877, 627/8, (Inc. 'A' versions) + 16xx OTPs.

**KIT 862... £29.99** Power Supply £3.99

## ICEBREAKER



## PIC Real Time In-Circuit Emulator

- ICEbreaker uses PIC16F877 in-circuit debugger.
- Links to standard PC **Serial** port (lead supplied).
- Windows (95 to XP) Software included
- Works with MPASM assembler
- 16 x 2 LCD display, Breadboard, Relay, I/O devices and patch leads.

Featured in *EPE Mar'00* Ideal for beginners & experienced users.

Programs can be written, downloaded, and then tested by single-stepping, running to breakpoints, or free run at up to 20Mhz.

**Full emulation means that all ports respond immediately - reading and driving external hardware.**

Features include: Run; set Breakpoint; View & change registers, EEPROM, and program memory; load program; 'watch window' registers.

**KIT 900...£34.99** With serial lead & software disk, PCB, Breadboard, PIC16F877, LCD, all components and patch leads.  
POWER SUPPLY - £3.99 STEPPING MOTOR 100 Step £9.99

## 20W Amp. Module

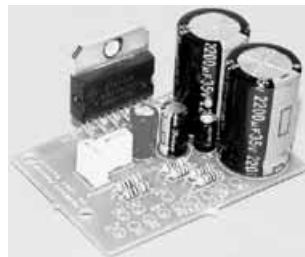
**EPE May '05 -- Superb Magenta Stereo/Mono Module**

**Wide bandwidth Low distortion 11W /channel Stereo 20W Mono True (rms) Real Power**

**Short Circuit & Overheat Protected. Needs 8 to 18V supply.**

**Stable Reliable design**

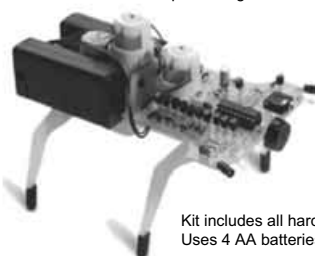
**Latest Technology IC with local feedback gives very high performance.**



**KIT 914** (all parts & heatsink for stereo or mono) **£11.90**

## Magenta BrainiBorg

A super walking programmable robot with eyes that sense obstacles and daylight: **BrainiBorg** comes with superb PC software CD (WIN95+ & XP) and can be programmed to walk and respond to light and obstacles on any smooth surface.



CD contains illustrated constructional details, operating principles, circuits and a superb **Educational Programming Tutorial**.

Test routines give real-time 'scope traces of sensor and motor signals. Connects to PC via **SERIAL** port with the lead supplied.

Kit includes all hardware, components, 3 motor/gearboxes. Uses 4 AA batteries (not supplied). *An Ideal Present!*

**KIT 912** Complete Kit with CD rom & serial lead **£49.99**

**KIT 913** As 912 but built & tested circuit board **£58.95**

## EPE PIC Tutorial

**EPE Apr/May/Jun '03 and PIC Resources CD**

- Follow John Becker's excellent PIC toolkit 3 series.
- Magenta Designed Toolkit 3 board with printed component layout, green solder mask, places for 8,18, 28 (wide and slim), and 40 pin PICs. and Magenta extras.
- 16 x 2 LCD, PIC chip all components and sockets included.

**KIT 880** (with 16F84) **£34.99**, built & tested **£49.99**

**KIT 880** (with 16F877) **£39.99**, built & tested **£55.99**

## EPE TEACH-IN 2004

**THE LATEST NOV 03 SERIES**

All parts to follow this new Educational Electronics Course. Inc. Breadboard, and wire, as listed on p752 Nov. Issue.

Additional Parts as listed in 'misc.' Section (less RF modules, Lock, and Motor/g.b.x)

Reprints: **£1.00 per part.**

**KIT 920.....£29.99** **KIT921.....£12.99**

## MAGENTA BRAINIBOT I & II

- Full kit with ALL hardware and electronics.
- As featured in *EPE* Feb '03 (KIT 910)
- Seeks light, beeps, and avoids obstacles
- Spins and reverses when 'cornered'
- Uses 8 pin PIC chip
- ALSO KIT 911 - As 910 PLUS programmable from PC serial port leads and software CD included.



**KIT 910....£16.99** **KIT 911....£24.99**

# MAGENTA

All prices include VAT. Add **£3.00 p&p**. Next day **£6.99**

072005

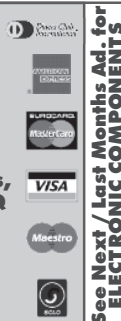


Station Road, Cullercoats,  
Tyne & Wear, NE30 4PQ

Prices Exclude Vat @17½%.  
UK Carriage £2.50 (less than 1kg)  
£5.50 greater than 1kg

Cheques / Postal orders payable to  
ESR Electronic Components.

PLEASE ADD CARRIAGE & VAT TO ALL ORDERS



See Next / Last Months Ad.  
ELECTRONIC COMPONENTS

### PCB Production - Development

#### 0.1" Copper Stripboard

Size	Trunks/Holes	£0.24
25 x 64mm	9T / 25H	
64 x 95mm	24T / 37H	£0.87
95 x 127mm	36T / 50H	£1.41
95 x 432mm	36T / 170H	£4.39
100 x 100mm	39T / 38H	£1.40
100 x 500mm	39T / 199H	£6.20
119 x 455mm	46T / 179H	£5.40
Stripboard track cutter		£1.99

#### Solderless Breadboard

Tie Points & Size	Power Rails
390 81 x 60mm 2	£2.75
840 175 x 67mm 2	£4.86
740 175 x 55mm 1	£4.03
640 175 x 42mm 0	£3.08

Many other sizes available,  
also jump wires & matrix board.

### PCB Production - Drafting Materials

AA A4 Work Film (per 10 sheets)	
Clear Manual Film	£1.25
Clear Laser Film	£1.75
White HQ Laser Film	£4.62
Etch Resist Pens	
"Dalo" Pen	£2.98
"Stageliner" Fine Pen	£0.88
Seno mixed DIL pads	£2.24
Seno mixed Rnd pads	£2.24
Alfac mixed pads	£1.84
Transfer Spatular	£1.25

We carry the full range of Seno & Alfac PCB transfers,  
see our catalogue for full details.

### Soldering Irons

We carry in stock a wide range of soldering iron and  
soldering accessories. Irons from 12 to 100 Watts.

20W 240V Basic £3.74

25W 240V Ceramic £7.14

30W 240V Basic £4.68

### Desolder Pumps

Basic 165 x 18mmØ	£2.85
Antistatic 195mm	£3.92
Antex Mini 198mm	£6.02
Antex Pro 210mm	£10.26

### Digital Multimeter

Model: 121-120

Price: £11.47

A highly featured digital  
multimeter for professional  
use. Offers 30 ranges and 8  
functions including tempera-  
ture, capacitance, diode,  
continuity and hFE measure-  
ment. Large 3.5 digit LCD  
display with automatic po-  
larity indicator. Supplied  
with shrouded test leads, K  
type temperature probe and  
shock proof rubber holster.

### Technical Specifications

DC voltage	200mV - 1000V
(±0.5%)	
AC volts	2V - 700V (±0.8%)
DC current	2mA - 20A (±1.2%)
AC current	200mA - 20A
(±1.8%)	
Resistance	200 Ohms - 20M
Ohms	(±0.8%)
Capacitance	2000pF - 20µF (±2.5%)
Temperature	0°C - 1000°C (±1.5%)
Frequency	20kHz (±1%)
Max display	1999
Power supply	9V (PP3 battery)
Dimensions	88 x 173 x 40 mm

### CCTV - Complete Systems

We carry the full range of  
Micromark Black & White and  
Colour CCTV systems for the  
home or office.

These complete easy install sys-  
tems are supplied complete with  
power supply, cables and all fix-  
ings. Simple plug-in connections,  
for use with any TV or Video with  
a scart socket.

### Black & White Systems from £22.97

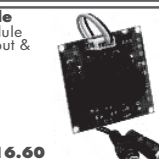
### CCTV - Black & White Module

A miniature CMOS camera module  
with a 3.6mm F2 Lens, video output &  
power via connectors provided.

#### Specs (660-800)

Power:	12Vdc 50mA
Video System:	CCIR
Pixels:	352 x 288
Min Illumination:	0.5Lux
Video Output:	1Vpp, 75Ω
Dims:	35 x 35 x 28mm 20g

£16.60



### PCB Production - Processing Equipment

We carry a large range of the photographic & chemical  
processing equipment for PCB production, a full list with  
full technical specifications is available in our catalogue  
or visit our web site.

#### UV Exposure units

2 x 8W Tubes, 6 min timer

229 x 159mm working area

Model 332-002 £88.78

4 x 15W Tubes, 7½ min timer

330 x 260mm working area

Model 332-004 £194.51

#### Chemical Processing

Low cost plastic tray £1.80

Process tanks feature electrically

operated pumps and/or heaters

with thermostat control, suitable

for boards upto 320 x 260mm.

Universal Tank with heater

Model 333-007 £161.60

Bubble etch Tank with heater

& bubble pump.

Model 333-004 £198.50

Any of these items, carriage £5.50



### PCB Production - Tools

#### Drill Bits

HSS parallel shank bits available in sizes from 0.3mm to

2.0mm

0.3-0.95mm in 0.05mm steps £0.60ea £4.00/10

1.0-2.0mm in 0.1mm steps £0.40ea £3.60/10

HSS Reduced shank (2.35mm) bit available in sizes from

0.6mm to 1.7mm in 0.1mm steps £0.84ea £7.60/10

Reground Tinsten carbide reduced shank (3.2mm) avail-

able in sizes from 0.6 to 1.6mm in 0.1mm steps £1.90

Drilling Machines

Expo reliant 12V drill, 3.8mm capacity, 8400rpm £12.78

Minicraft MX1 230V,

8000 - 21000rpm with

chuck & collet

Model EPE270-390

Normal price £48.51

**\*\* SPECIAL OFFER PRICE £31.02 \*\***

Servisol Products	
Aerosols	
200ml Switch Cleaner	£1.96
200ml Freezer	£3.97
400ml Foam Cleanser	£2.13
400ml Cleaner / lubricant	£2.79
75ml Video Head Cleaner	£1.94
200ml Aero Klene	£2.85
200ml Aero Duster	£4.66
250ml Cold Clean	£3.14
200ml Label remover	£3.52
400ml Isopropyl alcohol	£3.36
Tubes	
25g Heatsink Compound	£2.60
50g Silicone grease	£2.50

**NEW CATALOGUE  
OUT NOW**

available from [www.esr.co.uk](http://www.esr.co.uk)

### Educational Kits

These kits are an ideal way to start you interset in elec-  
tronics. They feature re-useable components which are  
attached via springs & wires and easy step by step  
guides to make a range of exciting projects. The 300-in-1  
features a breadboard for more complex circuits.

30-in-1	£13.18
50-in-1	£16.80
130-in-1	£32.29
300-in-1	£55.20

### Panel Meters

High quality analogue panel meters, class 2, zero point  
correction, mirror scale and prewired for panel illumina-  
tion. Meter size 46 x 60mm, Cutout size: 38mmØ.

Range	In-Ω	All meters £5.89 each
0-50uA	6k5	6V Lamps £1.23 / pair
0-100uA	1k0	
0-500uA	430Ω	
0-1mA	200Ω	
0-10mA	20Ω	
0-50mA	1Ω	
0-100mA	0.065	
0-500mA	0.012	
0-1A	60mΩ	
0-3A	20mΩ	
0-5A	12mΩ	
0-15A	4mΩ	
0-10V	10k	
0-15V	15k	
0-30V	30k	
±50uA	1k9	

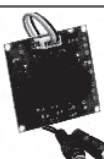
### CCTV - Colour Module

A miniature colour CMOS camera mod-  
ule with a 3.6mm F1.2 Lens, video output  
& power via connectors provided.

#### Specs (660-842)

Power:	12Vdc 150mA
Video System:	PAL
Pixels:	628 x 582
Min Illumination:	3Lux
Video Output:	1Vpp, 75Ω
Dims:	28 x 28 x 28mm 20g

£36.33



### PCB Production - Laminates

#### Copper clad - paper

Single sided low cost paper composite board

100 x 160mm Board £0.44

100 x 220mm Board £0.62

160 x 233mm Board £1.02

220 x 233mm Board £1.40

8" x 12" Board £1.70

#### Copper clad - glass fibre

Single & Double 1.6mm 305g/m²

100 x 160mm Single £0.85

100 x 220mm Single £1.25

160 x 233mm Single £2.29

220 x 233mm Single £2.68

8" x 12" Single £3.44

100 x 160mm Double £0.88

100 x 220mm Double £1.25

160 x 233mm Double £2.30

220 x 233mm Double £2.90

8" x 12" Double £3.50

#### Photoresist Coated

1.6mm 35 micron Pre-coated with a high quality photo-  
resist layer. Available in low cost paper composite or  
Glass fibre, Single & Double sided. Other sizes also  
available.

Size	Paper	Double	Glass Fibre	Double
------	-------	--------	-------------	--------

4 x 6" £1.47 £1.82 £1.89 £2.17

6 x 12" £4.20 £5.04 £5.60 £6.23

9 x 12" £6.30 £7.70 £8.40 £9.38

10 x 12" £8.19 £10.01 £10.78 £11.83

12 x 12" £8.26 £10.08 £10.99 £12.25

100 x 160mm £2.38 £2.66

203 x 114mm £3.01 £3.43

220 x 100mm £3.08 £3.71

233 x 160mm £4.83 £5.32

233 x 220mm £6.83 £7.70

### PCB Production - Chemicals

100ml Aerosol Photoresist spray, covers 2m² £4.25

50g Powder developer, makes 1lt £1.09

500g Powder developer, makes 10lt £7.08

250g Ferric Chloride Pellets, makes 500ml £1.68

500g Ferric Chloride Pellets, makes 1lt £3.04

2.5kg Ferric Chloride Pellets, makes 5lt £17.58

1.1kg Clear Fine etch crystals, makes 5lt £11.58

90g Tin Plating Powder, makes 1lt £3.41

200ml Aerosol Flux spray £3.41

110ml Aerosol PCB Lacquer spray £3.63

**Magnifying Desk Lamp**

A high quality scratch resistant  
magnifying glass fitted to a bal-  
anced swivel arm and desk  
mount. An integral fluorescent  
tube provides illumination.  
Magnification: 3x Lens: 120mmØ  
Tube: 22W Daylight simulation.

Model: 028-205 £28.80

**Tools - Cutters & Strippers**

We carry a wide range of specialist tools for the elec-  
tronics industry including:

Side Cutters	
130mm Low cost	£1.99
115mm Draper	£2.38
115mm Box Jointed	£4.26
145mm Long reach	£3.40

Wire Strippers

130mm Low cost £2.30

150mm Draper 5mmØ £5.86

### Tools - Ratchet Crimping Pliers

High quality ratchet crimping pliers for various terminals

including Automotive, Data, Power and Data connections.

Red / Blue / Yellow £15.80

BNC / TNC RF series £15.08

RJ11 / 12 Data Series £22.32

RJ45 Data Series £20.43

R111 / 12 & 45 Series £12.64

### CK® Tools Crimp Pliers

Green/Red/Blue £24.38

Red/Blue/Yellow £22.88

0.24-2.5mm² crimps £26.01

0.5-6.0mm² crimps £26.01

Non insulated crimps £24.38

### Cable - Ribbon

7/0.127mm Grey ribbon cable on a 0.05" 1.27mm pitch  
with a red identifying stripe. Supplied by 305mm (1ft) or  
on full 30.5m (100ft) reels.

Size per 305mm per Reel

10 Way £0.10 £5.36

14 Way £0.14 £7.50

16 Way £0.16 £8.58

20 Way £0.20 £10.72

26 Way £0.26 £13.94

34 Way £0.34 £18.22

40 Way £0.40 £21.44

50 Way £0.50 £26.80

60 Way £0.64 £33.92

IDC Crimp tool £11.80

### CAT 5e Networking

UTP Cable

305m Box, conforms to

CAT5E 100MHz standard,

ETA verified TIA/EIA 568-B.2

Only £23.93 per box

exc carriage.

### RJ45 Outlet Kit

Backing Box

2 Gang Plate

RJ45 Module

Blank Module

Colour coded id

inserts.

special price £2.99

Tools



# EVERYDAY PRACTICAL ELECTRONICS

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

## VOL. 34 No. 9 SEPTEMBER 2005

### Editorial Offices:

EVERYDAY PRACTICAL ELECTRONICS EDITORIAL  
Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown,  
Dorset BH22 9ND  
Phone: (01202) 873872. Fax: (01202) 874562.

Email: [enquiries@epemag.wimborne.co.uk](mailto:enquiries@epemag.wimborne.co.uk)

Web Site: [www.epemag.co.uk](http://www.epemag.co.uk)

EPE Online (downloadable version of EPE): [www.epemag.com](http://www.epemag.com)

EPE Online Shop: [www.epemag.wimborne.co.uk/shopdoor.htm](http://www.epemag.wimborne.co.uk/shopdoor.htm)

See notes on **Readers' Technical Enquiries** below – we regret lengthy technical enquiries cannot be answered over the telephone.

### Advertisement Offices:

EVERYDAY PRACTICAL ELECTRONICS ADVERTISEMENTS  
408 Wimborne Road East, Ferndown, Dorset BH22 9ND  
Phone: 01202 873872 Fax: 01202 874562

Email: [stewart.kearn@wimborne.co.uk](mailto:stewart.kearn@wimborne.co.uk)

## The Wonders of Technology

I'm sat by a swimming pool outside of a four star hotel in Cape Town, courtesy of South African Airways, writing this. I met our regular contributor Thomas Scarborough, who lives in Cape Town, a couple of days ago following a sports tour I had been on with my wife, who coaches netball, and 21 netball and hockey players. Our flight home was cancelled due to an on-going strike by South African Airways staff. Technology has allowed us to stay in touch with home and office during the tour and also allowed me to write this and zoom it around the world to be in print a few days later.

The problem is that, with all SAA International flights cancelled, we have no way of getting everyone home for a few days until there is space on a BA flight. I guess what we need is a teleport system but even if such a thing were possible it could still be defeated by an operator's strike!

## Problems

The problems are further compounded by system overload when everyone wants to use their mobile phones or the Internet. Technology is great when everything is fine but I don't think we have yet got the systems we need when unusual circumstances result in exceptional use. And no doubt we will always be in the hands of workers who might strike for better pay or conditions.

Meeting Thomas in Cape Town was a bonus of the tour, he presented me with an unusual project for future publication and also demonstrated a prototype magnetic field detector which he is presently working on. I also met his son Matthew who is responsible for many of the ideas Thomas turns into working projects.

EPE is truly international, not only in sales but also with contributors like the Reverend Thomas that provide the wide variety of unusual projects that make EPE what it is today.



### AVAILABILITY

Copies of EPE are available on subscription anywhere in the world (see opposite), from all UK newsagents (distributed by COMAG) and from the following electronic component retailers: Omni Electronics and Yebo Electronics (S. Africa). EPE can also be purchased from retail magazine outlets around the world. An Internet on-line version can be purchased and downloaded for just \$14.99US (approx £8) per year available from [www.epemag.com](http://www.epemag.com)

### SUBSCRIPTIONS

Subscriptions for delivery direct to any address in the UK: 6 months £16.50, 12 months £31, two years £57; Overseas: 6 months £19.50 standard air service or £28.50 express airmail, 12 months £37 standard air service or £55 express airmail, 24 months £69 standard air service or £105 express airmail. To subscribe from the USA or Canada see the last magazine page.

Online subscriptions, for downloading the magazine via the Internet, \$14.99US (approx £8) for one year available from [www.epemag.com](http://www.epemag.com).

Cheques or bank drafts (in £ sterling only) payable to Everyday Practical Electronics and sent to EPE Subs, Dept., Wimborne Publishing Ltd, 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872. Fax: 01202 874562. Email: [subs@epemag.wimborne.co.uk](mailto:subs@epemag.wimborne.co.uk). Also via the Web at: <http://www.epemag.wimborne.co.uk>. Subscriptions start with the next available issue. We accept MasterCard, Amex, Diners Club, Maestro or Visa. (For past issues see the Back Issues page.)

### BINDERS

Binders to hold one volume (12 issues) are available from the above address. These are finished in blue p.v.c., printed with the magazine logo in gold on the spine. Price £7.95 plus £3.50 p&p (for overseas readers the postage is £6.00 to everywhere except Australia and Papua New Guinea which cost £10.50). Normally sent within seven days but please allow 28 days for delivery – more for overseas.

Payment in £ sterling only please. Visa, Amex, Diners Club, Maestro and MasterCard accepted. Send, fax or phone your card number, card expiry date and card security code (the last 3 digits on or just under the signature strip), with your name, address etc. Or order on our secure server via our UK web site. Overseas customers – your credit card will be charged by the card provider in your local currency at the existing exchange rate.

Editor: MIKE KENWARD

Deputy Editor: DAVID BARRINGTON

Technical Editor: JOHN BECKER

Business Manager: DAVID J. LEAVER

Subscriptions: MARILYN GOLDBERG

General Manager: FAY KEARN

Editorial/Admin: (01202) 873872

Advertising Manager:

STEWART KEARN (01202) 873872

On-Line Editor: ALAN WINSTANLEY

EPE Online (Internet version) Editors:

CLIVE (MAX) MAXFIELD and ALVIN BROWN

### READERS' TECHNICAL ENQUIRIES

E-mail: [techdept@epemag.wimborne.co.uk](mailto:techdept@epemag.wimborne.co.uk)

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by a **stamped self-addressed envelope or a self-addressed envelope and international reply coupons.**

### PROJECTS AND CIRCUITS

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.

A number of projects and circuits published in EPE employ voltages than can be lethal. **You should not build, test, modify or renovate any item of mains powered equipment unless you fully understand the safety aspects involved and you use an RCD adaptor.**

### COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers (see *Shoptalk*). **We advise readers to check that all parts are still available before commencing any project in a back-dated issue.**

### ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY PRACTICAL ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or in inserts.

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture.

### TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before buying any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use or ownership. The laws vary from country to country; readers should check local laws.



# All-Band Radio

Thomas Scarborough

A no frills, low budget, easy-build, sensitive radio with excellent reception

ONE might call this a “dog” of a radio. It doesn't pretend to any finesse. It doesn't have high fidelity sound. However, it has good coverage, and good sensitivity. Moreover, it is a robust design that, unlike many others, does not depend on daintily wound coils, obscure parts, or a carefully constructed antenna.

Built in Cape Town, South Africa, the prototype All-Band Radio brought in a good many stations from all around the world – loud and clear. This included the BBC, the Voice of America, Radio China, Radio Iran, the Deutsche Welle, and many more besides. Well into the night, it even picked up local Australian stations on the medium waves.

## Regeneration

Despite its simplicity, this regenerative set has sharper tuning and greater sensitivity than many other tuned radio frequency (t.r.f.) sets. On the medium waves, it works well even without an external antenna or earth, although an aerial may be attached to very good effect. Also, while its volume is modest, it is strong enough to serve as a bedside radio, or in a small workshop.

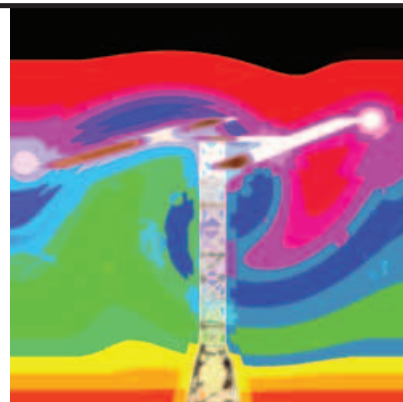
A regenerative radio is interesting to work with. It might be compared with a manual car as opposed to an automatic. In addition to the customary Volume control and Tuning dial, it has a third Regeneration dial to control regeneration. Regeneration “regenerates” the received signal, much as a child on a swing increases the energy of the swing with modest kicks of its legs. This type of radio was invented by Major Armstrong in 1912, bringing about a vast improvement in radio receivers at that time.

At first it was thought that the set's maximum frequency would lie around 5MHz – that is, the shortwave 60 metre band. In practice, however, it picked up radio stations above 7MHz. Therefore it has the potential to tune in the following bands:

<i>Long Wave</i>	
<i>Medium Wave</i>	
<i>Marine Band</i>	
<i>Short Wave</i>	
	<i>120 metres</i>
	<i>90 metres</i>
	<i>75 metres</i>
	<i>60 metres</i>
	<i>49 metres</i>
	<i>41 metres</i>



Front panel controls for the full version of the All-Band Radio



## Mini Radio

At the heart of this radio circuit is the 4069UB (unbuffered) hex inverter i.c. which is able to provide a powerful signal into a crystal earpiece. Therefore, the circuit obviously has the potential for miniaturisation. With this in mind, the author further designed a p.c.b. layout for a miniature radio (see Fig.4), and it remains to the ingenuity of the constructor to fit this into a suitably small plastic case.

## Circuit Description

As mentioned above, the heart of the circuit is represented by inverting buffer IC1a (see Fig.1). Although this is classed as a digital device, it may in some situations serve as an analogue amplifier up to several megahertz, albeit without the same quality of reproduction as a dedicated analogue amplifier i.c.

The full circuit diagram for the All-Band Radio is shown in Fig.1. When a station is tuned in, variable capacitor VC1 and coil L1 resonate at the tuned frequency. In other words, they present a minuscule alternating voltage to the input of IC1a through d.c. blocking capacitor C1. Therefore any activity in the tuned circuit unsettles both the input and the output of IC1a, sending ripples down the chain IC1a to IC1f, which are amplified and demodulated as they go.

To bring about regeneration, the tuned circuit is inserted in the feedback path of IC1a, while resistor R1 and potentiometer VR1 serve to balance IC1a at roughly half the supply voltage. The higher the value of VR1, the greater IC1a's potential for being unsettled, and the greater the regeneration as the amplified signal at input pin 1 is passed back through the tuned circuit via output pin 2.

The purpose of regeneration is to reinforce the r.f. signal through positive feedback. Not only does this make the signal louder, but it also sharpens it a great deal. As a matter of interest, Fig.2 shows how this circuit might have looked if a more standard tuned radio frequency (t.r.f.) configuration had been used, and it would be instructive to try this out. The result is much vaguer tuning, and reduced volume.

When using the radio, regeneration needs to be held as high as possible without introducing instability to the circuit.



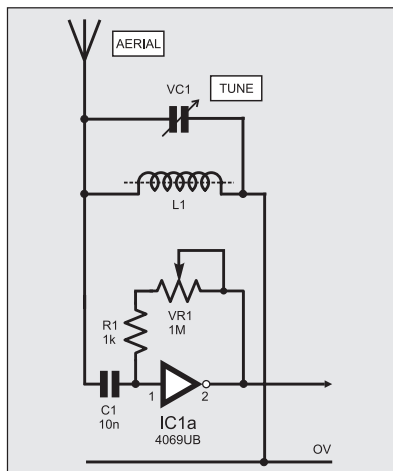
Inverter IC1b serves to amplify the radio frequency (r.f.) signal, while diode D1 provides demodulation (that is, it extracts the audio signal). A common disadvantage of using a simple diode for demodulation is that this may kill weaker signals through its voltage drop; hence the choice of a *germanium* type. Therefore before demodulation is applied to this circuit, r.f. amplifier stage IC1a is added. Diode D1 thus demodulates a far stronger r.f. signal, and far fewer stations are lost in the process.

One of the particular advantages of this design is that virtually any tuned circuit may be tried for VC1 and L1, on condition that this is tuned to less than about 8MHz. So, for instance, various coils and a.m. tuners (tuning capacitors) may be pulled out of junked radio circuits, and the majority would be likely to work, possibly with interesting results.

The most commonly available a.m. tuning capacitors typically have two separate sections (that is, two variable capacitors with one common terminal – ask your component shop to identify the terminal pins). A tuned circuit for the medium waves could use such a tuner with its two separate sections wired in parallel, together with L1 which would be about eighty to a hundred turns of 30s.w.g. (0.15mm)

In order to access higher frequencies, thicker gauges of wire would be used, with fewer turns, spaced out more widely on the ferrite rod, or even being air-spaced. The author accessed the 41 metre shortwave band with an air-spaced coil which was wound on a 25mm diameter former, with 10 turns of 24s.w.g. (0.56mm) enamelled copper wire. This was then stretched out to 25mm from end to end.

As a matter of interest, Raymond Haigh's, series *Practical Radio Circuits* (EPE Sept '03 P646) gives some examples of coils which could be tried to bring in different frequencies. Note also that since



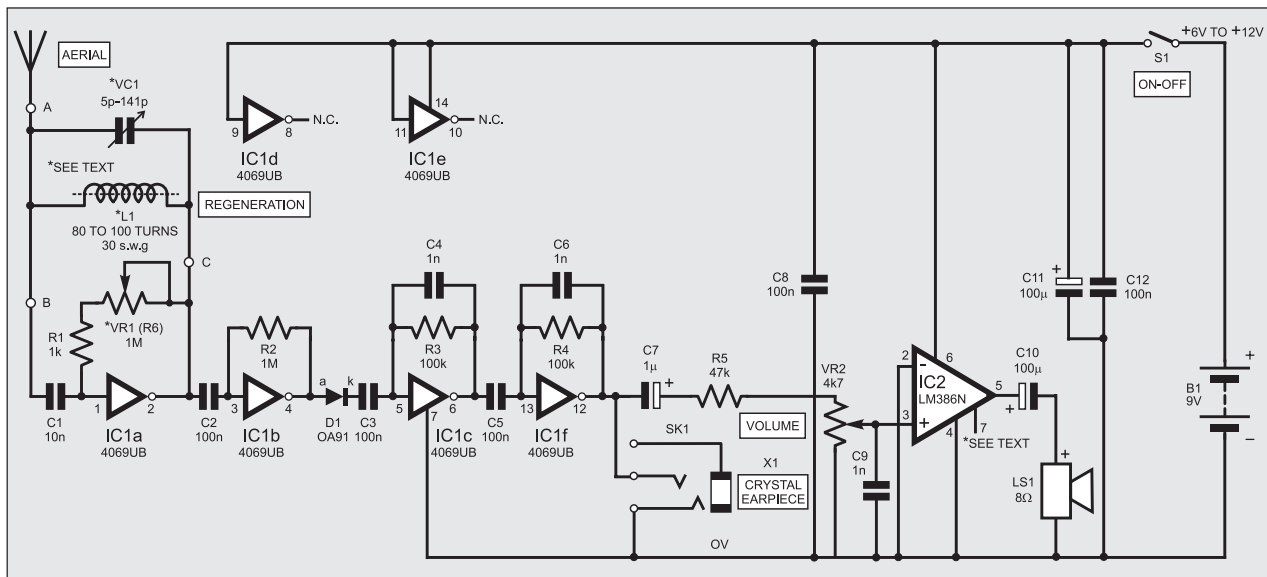
If the miniature version of the Radio should be built, coil L1 may be compressed by using a short stub of 10mm diameter ferrite rod, pile-winding eighty to a hundred turns of 30s.w.g. (0.315mm) enamelled copper wire on the stub. The a.m. tuning capacitor may further be miniaturised by wiring a trimmer capacitor, in series with a small fixed value capacitor, in its place. The fixed value would need to be chosen experimentally so as to pick up one's chosen radio station or stations, since the tuning range would be reduced in this case.

Theoretically, the tuner may be no more than two metal plates with a dielectric (e.g. a sheet of plastic). Many years ago, the author bought the Soviet Astrad Orion, which was possibly the smallest radio ever to have become widely available. Out of curiosity, it was opened up to examine the tuning capacitor, and a single metal plate fell out. This, together with a plate on the front of the case, formed the tuning capacitor.

In order to experiment intelligently with the All-Band Radio, one should best have some understanding of the  $Q$ -factor. The radio as shown (Fig.1) has been designed for a relatively high  $Q$ , although it does not depend on this to work reasonably well.

A common definition of  $Q$  is “the ratio of the reactance of an inductor (in this case coil L1) to its effective series resistance at a given frequency”. However, a simple way of putting this is that  $Q$  represents the “power” with which the tuned circuit resonates at a given frequency. As in many situations, it is one thing to get something to work – it is another to get it to work *efficiently*.

The formulae for calculating the ideal  $Q$  are relatively complex, but two factors are especially important for obtaining a good  $Q$ .



# COMPONENTS

## Resistors

R1	1k
R2	1M
R3,R4	100k (2 off)
R5	47k
R6	1M (see text)

All 0.25W 5% carbon film

## Potentiometers

VR1	1M min. carbon track or conductive plastic, 5mm pitch
VR2	4k7 min. carbon track or conductive plastic, 5mm pitch

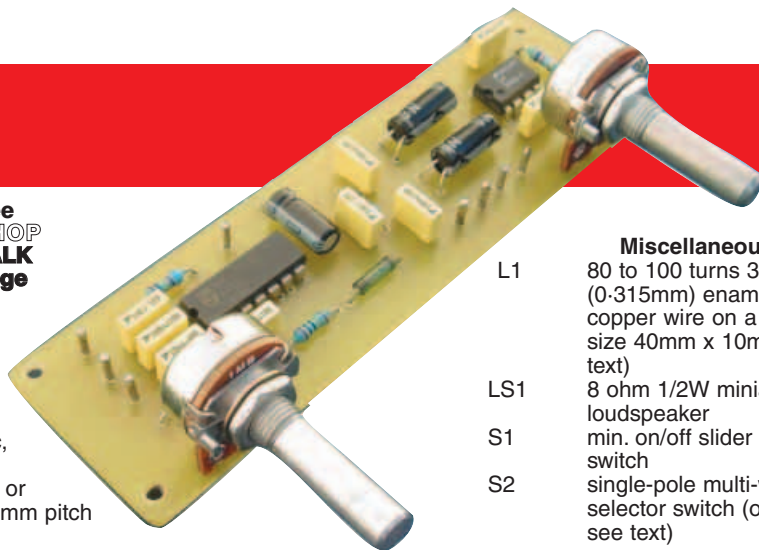
## Capacitors

C1	10n polyester or ceramic
C2,C3,C5,	
C8,C12	100n polyester or ceramic (5 off)
C4,C6,C9	1n polyester or ceramic (3 off)
C7	1 $\mu$ radial elect. 16V
C10,C11	100 $\mu$ radial elect. 16V (2 off)
VC1	126p, 141p a.m. variable, with trimmers (see text)

## Semiconductors

D1	OA91 or similar germanium diode
IC1	4069UB (unbuffered) CMOS hex inverting buffer i.c.
IC2	LM386N-1 audio amplifier i.c.

See  
SHOP  
TALK  
page



## Miscellaneous

L1	80 to 100 turns 30s.w.g. (0.315mm) enamelled copper wire on a ferrite rod, size 40mm x 10mm (see text)
LS1	8 ohm 1/2W miniature loudspeaker
S1	min. on/off slider or toggle switch
S2	single-pole multi-way Band selector switch (optional – see text)
SK1	2.5mm or 3.5mm mono jack socket, chassis mounting (optional)
X1	crystal earpiece optional – see text)
B1	9V battery (PP3 type), with clips



Printed circuit boards available from the *EPE PCB Service*, codes 523(Full) and 524(Mini); case, size 130mm x 70mm x 40mm approx. (or to suit Mini version); 8-pin d.i.l. socket; 14-pin d.i.l. socket; plastic knob (3 off); aerial wire; screened microphone cable (about 30cm); cable ties; solder tag; solder pins; solder etc.

Approx. Cost  
Guidance Only

**£16**

excl case and batts

The first is that fine wire should be used for coil L1, or more exactly that the skin effect should be avoided – a complaint that applies to thicker wire gauges, and raises the effective (a.c.) resistance of the coil. Often, therefore, a coil is wound with several strands of fine wire twisted together but insulated from each other, being equivalent in their total cross-sectional area to the wires they replace.

A second factor is to maximise the influence of coil L1 on the tuned circuit, and to minimise capacitance and resistance. This is done by minimising the value of variable capacitor VC1, and by maximising the value of coil L1 – as well as minimising any resistance in the tuned circuit.

Described from a practical point of view, some tuned circuits will cause the All-Band Radio to pick up stations at full volume, while others will cause it to pick them up more quietly. Therefore if you should decide to recycle a tuned circuit from another radio, it might be worth taking it out of a full-sized radio set to obtain good *Q*, and to choose a case for the All-Band Radio that is able to accommodate this. This will ensure a reasonably strong sound input to the loudspeaker.

It is known that the *Q*-factor suffers especially when miniaturising the tuned circuit, and for this purpose, it is possible to increase the amplification of the All-Band Radio. Resistor R2 may be increased up to about 4M7, R3 may likewise be increased up to about 4M7, and R4 may be increased a little (say to 220k $\Omega$ ).

## Audio Circuit

Two preamplifier stages (IC1c and IC1d) follow after the r.f. section. Their gain is set through resistors R3 and R4. Each of these

stages filters out high frequencies (including radio frequencies) with the use of a small feedback capacitor (C4 and C6). A reduction of the values of these capacitors gives a “sharper” sound, arguably increasing the clarity of reception. However, this also increases hiss. The two spare inverter gates IC1d and IC1e (IC1 pins 9 and 11) are “tied high” to prevent any instability.

Note that because this circuit is based on a cheap CMOS 4000-series i.c. instead of dedicated radio and audio i.c.s, its sound quality suffers somewhat, in particular through the introduction of hiss. However, for everyday listening, the quality is quite adequate.

The two preamplifier stages are followed by a Volume control (VR2) and a low-pass filter (C9). A basic hazard of radio circuits is that the audio amplifier might be fed with radio frequencies (r.f.) that have slipped through the preceding stages, thus overloading the amplifier. The amplifier thus works too hard with signals that the listener is unable to hear. Therefore adequate filtering is important. Notice also the decoupling capacitors C8, C11, and C12, which are not used merely for “good practice”, but make a noticeable difference to sound quality.

Using the popular LM386 audio amplifier i.c., IC2 is capable of providing up to about 1/2W r.m.s. at 9V into an 8 ohm loudspeaker. If desired, its gain may be increased by wiring a capacitor between pins 1 and 8 of IC2, the value of which may be between about 100nF and 10 $\mu$ F. The capacitor's positive terminal is wired to pin 1.

The usual Zobel network at the output is omitted for the sake of simplicity. The small measure of protection which a Zobel

network would afford IC2's internal transistors ought not to be missed here, although constructors of a more nervous disposition might wish to wire a 10 $\Omega$  resistor and a 100nF capacitor in series from IC2 output pin 5 to the 0V line.

For the miniature version of the Radio, IC2 is completely omitted, leaving a powerful “crystal” set which feeds a crystal earpiece (X1), via jack socket SK1, wired from IC1f output pin 12 to 0V – or an inductive earpiece may be used if it is wired in series with a 1 $\mu$ F capacitor.

The All-Band Radio's quiescent current consumption is relatively high. The miniature version of the radio draws about 30mA at 9V, while the fully built version with amplifier and speaker will consume upwards of 50mA, depending on the volume. This means that an alkaline PP3 type 9V battery might last ten or fifteen hours for the miniature version, and five or eight hours for the fully built version.

For regular use, therefore, a regulated mains-to-d.c. power supply (mains adaptor) might be considered. If there should be any hum as a result of using a power supply, a 10 $\mu$ F capacitor may be wired from IC2 pin 7 to 0V, and this is likely to improve matters significantly. Alternatively, a better quality supply might need to be used.

## Construction – Full Version

Since this is a radio circuit, it is of prime importance that connections to off-board components should be made with screened microphone cable. The screen is always taken to 0V where this applies. The wires from L1 and the battery may be excepted on condition that these are kept as short as reasonable.



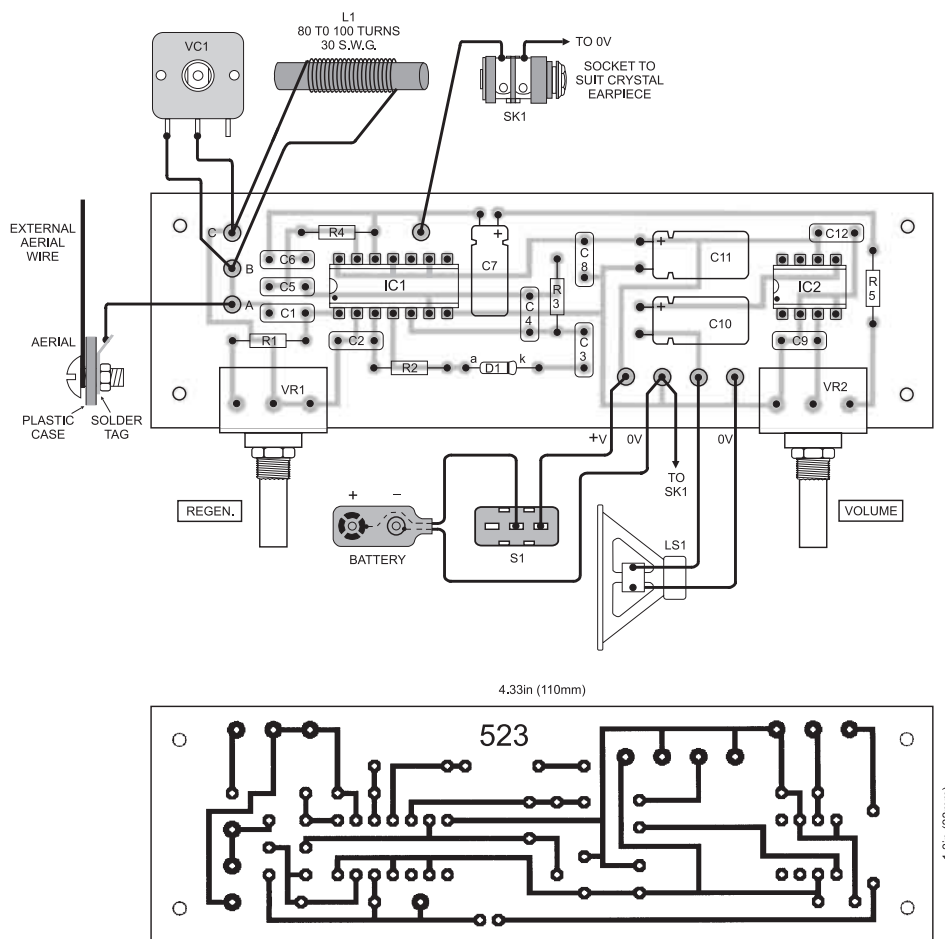


Fig.3. Printed circuit board component layout, full-size copper foil master and off-board wiring details for the full version of the All-Band Radio

The printed circuit board (p.c.b.) for the fully built version measures 110mm × 33mm, and the component layout, full-size copper foil master and wiring details are shown in Fig.3. This board is available from the *EPE PCB Service*, code 523 (Full).

Begin construction by soldering in position the eight solder pins, five resistors and twelve capacitors, taking note of the polarity of the electrolytics. Insert and solder potentiometers VR1 and VR2 on the p.c.b.

Lastly, solder the germanium diode D1 and the two i.c.s – observing anti-static precautions for both (ensure that your body has been discharged to earth). The author soldered the i.c.s directly to the p.c.b., for the reason that this is a sensitive radio circuit, however readers can, if they wish, use dual-in-line (d.i.l.) sockets.

Attach the loudspeaker LS1 and tuning capacitor VC1 to the p.c.b. with suitable lengths of microphone cable. Attach the battery clip and on-off switch S1 as shown. Solder the leads of coil L1 to the p.c.b., keeping these as short as possible.

## Casing-Up

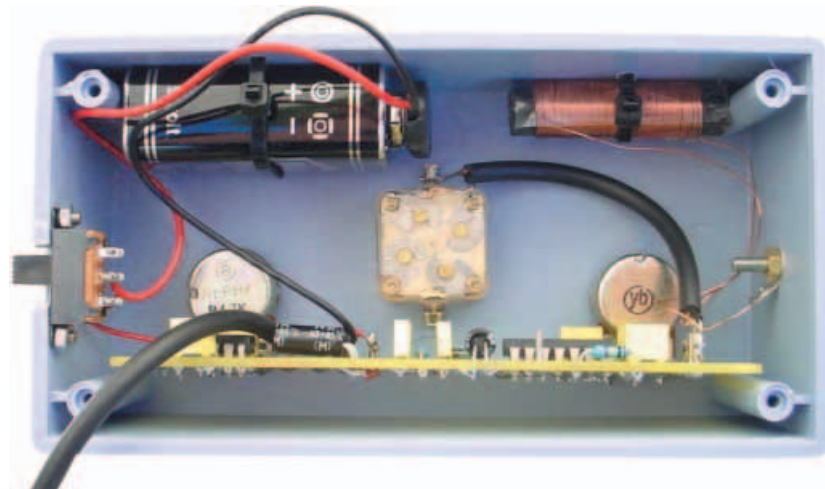
An ABS plastic case of approximately 130mm × 70mm × 40mm was used to house the prototype p.c.b. Drill three holes in the front (bottom) of the case for VR1, VR2 and VC1. Drill a series of “sound”

holes in the lid (rear) for the small loudspeaker and then attach it to the rear of the lid (or elsewhere, if a larger case is used). Make sure there is plenty of room between the rear of the speaker and the circuit board.

Prepare a hole in one side wall for the on-off switch S1. Drill a hole and bolt a solder tag to the other side wall of the case, taking a short length of wire from

the tag to the p.c.b. This is used later to attach an aerial if desired. The author held the battery and ferrite coil L1 in place inside the case with cable ties, see photograph below.

If desired, a number of different coils for L1 may be switched in and out of use, so as to access the different bands. For this purpose, a single-pole multi-way rotary switch would be used.



Internal component layout of the radio showing the battery and ferrite coil held in position with cable ties.

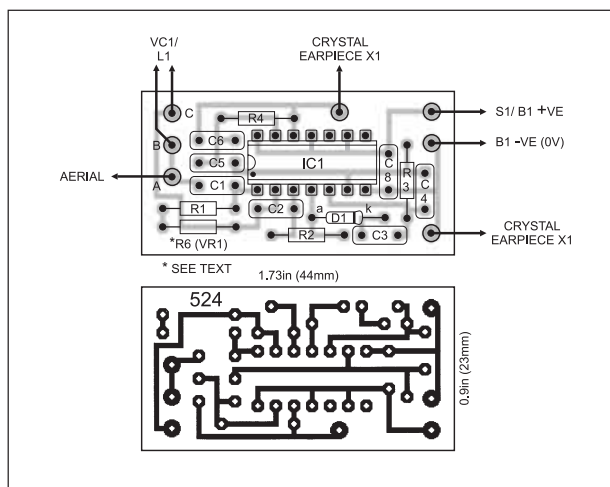
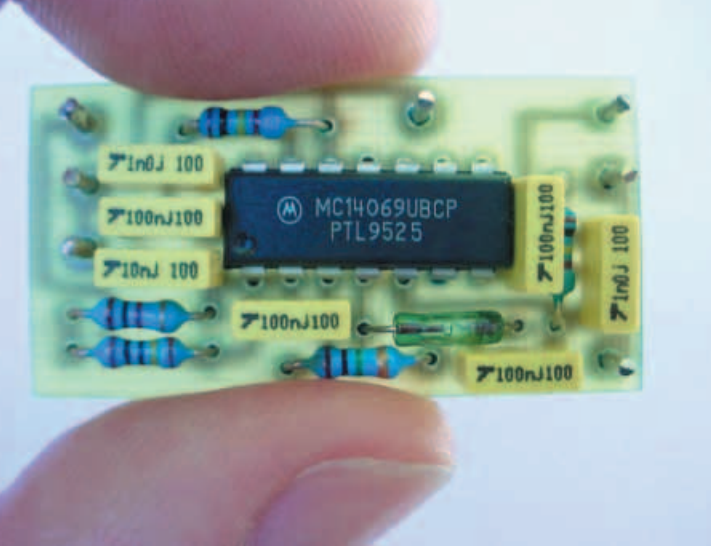


Fig.4. Mini version p.c.b. component layout, wiring and copper foil master

## Completed Mini Radio circuit board

## Construction – Mini Version

The p.c.b. component layout and full-size copper foil master for the miniature version of the Radio, which measures a mere 44mm × 23mm, is shown in Fig.4. This board is also available from the *EPE PCB Service*, code 524 (Mini).

The mini version has potentially the same performance as the fully built version, except that it uses an earpiece instead of a loudspeaker. A jack socket SK1 may be used for the earpiece X1, or it may be soldered directly to the p.c.b., with a dab of glue acting as a strain relief for X1's leads.

Commence construction by soldering in position the seven solder pins and five resistors. Note that Regen. control VR1 is replaced on this p.c.b. with a one megohm (1M $\Omega$ ) fixed value resistor, to conserve space. A 1M $\Omega$  potentiometer may by all means be used instead. A 1M $\Omega$  fixed value resistor should not cause excessive regeneration unless a particularly generous length of aerial is used.

Next, insert and solder in position the seven capacitors, the germanium diode D1 and IC1, again observing anti-static precautions with the i.c. Coil L1 and tuning capacitor VC1 may be miniaturised as described earlier.

Finally, a suitable miniature slider or toggle type switch is wired up, together with a battery or batteries. Bear in mind that current consumption is relatively high, and some smaller batteries might only last

an hour or so. Any batteries from 6V to 12V may be used. A possible choice would be a standard small keyfob battery, the MN21 or A23.

## Set-Up and Use

Begin the setting up procedure by turning the Regeneration control (VR1) fully clockwise. Turn up the Volume control (VR2) to about half. Switch on – then turn the tuning dial (VC1) until a station is tuned in.

On the medium waves in Europe or North America, there should be no shortage of stations even without an external aerial. However, in Southern Africa or Australia, stations may be relatively few and far between – perhaps just one or two until night falls and an aerial is attached. As with all medium and short wave sets, reception is very much improved at night, particularly as one approaches midnight.

If without an external aerial nothing at all is tuned in on the medium waves, try re-orientating coil L1 for better reception. Alternatively, L1 and tuning capacitor VC1 may not be covering the desired frequencies, and another coil might be required.

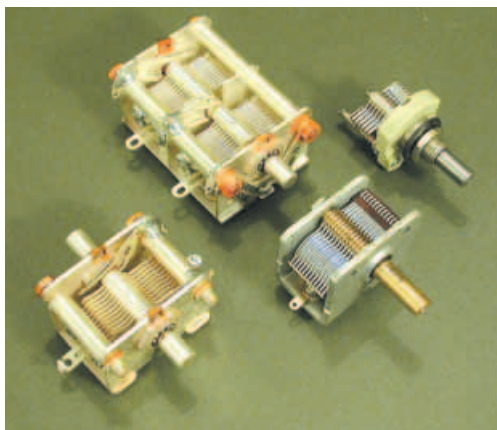
If, even with an aerial, nothing at all is tuned in, check that all components are correctly placed on the p.c.b., and that there are no solder bridges or dry solder joints. Since this is a sensitive radio circuit, it might be worth briefly melting each joint again with the soldering iron. Inadequate joints are seldom visible to the eye.

If there is excessive regeneration or instability in the form of “shrieks” or “judging”, first try turning down the volume (VR2). If this does not restore stability, reduce regeneration by slowly turning back VR1. Once stability returns, the volume may be turned up again. Regeneration needs to be kept as high as possible, so that tuning is as sharp as possible.



Once the All-Band Radio is working satisfactorily, different coils may be substituted for L1, or these may simply be wired in parallel with L1 as described earlier. Avoid attaching coils with crocodile clips, since such clips are bulky, and may lead to stray r.f. and capacitive effects that could kill reception completely. Rather use short leads which are wired directly to the p.c.b., or to solder tags close to the p.c.b.

Happy listening!



Group of air-spaced variable capacitors



## SOUNDS OF THE FUTURE

**As conventional audio sales decline, surprising technological alternatives could soon be booming. Barry Fox reports**

**C**ONFIDENTIAL trade figures from JEIDA, the Japanese electronics industry trade body, show conventional audio in terminal decline. Sales of multi-speaker systems are flagging. The only hope, Japanese manufacturer Marantz told European press and dealers at a seminar in Italy recently, is for the audio trade to take the Swiss watch industry as a model and completely re-think its business strategy.

Apple has done it with iPod and Bose has done it with direct sales. Marantz will not sell direct and Apple tightly controls the iPod world. The challenge now is to find something for mainstream audio, admits Marantz.

As part of the quest for something new and appealing, Marantz gave the first demonstration of a system called *Opsodis* that was developed by Southampton University to deliver surround effects from three front speakers.

### Facts and Figures

The confidential trade figures came from Marantz "Brand Ambassador" Ken Ishiwata. Constrained by copyright, Ishiwata only flashed figures on screen for quick hands to note.

Figures for world TV sales, he says, show "no drastic drop in CRT sales yet", especially in the US where they remain "very significant". China is now the biggest TV market in the world, with 30.4 million TV sets sold in 2004, 31.7m expected in 2005 and 33m anticipated for 2006.

A total of 147m TV sets of all kinds sold in 2004, with 153m expected this year and 190m predicted for 2009. Flat panel displays were at 10.3m for 2004, 18m for 2005 and 28.4 expected for 2006.

Of total TV sales worldwide for 2004, 7% were flat panels in 2004, with 11.7% this year and 17.6% due next year. But in Japan the figures are 32%, 48% and 65% for the same years; while in Western Europe the figures are 11.6%, 18.9% and 26.7%, with the US at 9%, 15.8% and 24.3%.

"The industry trend is towards \$40 per inch for flat panels by the end of the decade" says Ishiwata.

The world market for DVD is still growing, with 85m players sold in 2004, 91.6m selling in 2005 and 97.1 in 2006. VHS is collapsing from 16m last year to 11.5m in 2005 and 8.2m next year, while DVD recorder sales have risen from 8.5m in 2004 to 15.2m this year. There is no breakdown from JEIDA on recorder format sales yet.

Home audio sales are slowing worldwide from 63.7m worldwide to 63m and 62.3m, of which 34.7m, 34.8m and 34.6m are mini/micro systems. Amplifier/receiver sales are stagnant at 5.3m, 5.2m and 5.2m.

### Emotions to the Fore

"So what are we going to do to increase audio sales?" asks Ishiwata. "The best lesson is from what happened in the 1970s when the Japanese watch industry killed the Swiss manufacturer's business. The Swiss came back by offering sexy, attractive products that created desire. It was about emotion.

"Music is about emotion, too. You can't buy Swiss watches on the Internet either. It's time for the specialist audio manufacturers to do something like the Swiss watch industry. To make people say – 'I want that'. There has to be a different approach, which people feel something is different. Apple did it with the iPod. They took away Sony's market. I really hope we can see something similar in hi-fi.

"Bose have done a wonderful job from a business point of view. They knew exactly where they were going. They communicated and created brand awareness. They bypassed the distribution and were consistent. They are the most consistent company in audio".

Marantz will not even consider direct sales. "Our dealers are our partners" says Ken Ishiwata. "We have a contract with our European dealers. It was carefully checked with lawyers. B&O have a similar control system. If any dealer sells by mail order, or on the Internet, their contract is terminated.

"But there is nothing we can do if a mail order company buys from an authorised dealer and then sells over the Internet" admits Ishiwata. "They do that so that they can use our name in their lists. They lose money by buying from an authorised dealer and then selling on at below cost, but they make money in the long run by being able to promise all brands."

### Cancelling Surrounded

Marantz is now evaluating a new technology called Opsodis, a commercial spin-off from Southampton University in the UK. Opsodis builds on the well-known crosstalk cancellation principle to create 3D surround from front speakers. Sound from the left channel is reversed in phase and added to the right channel so that it cancels out and the right ear hears only the right channel.

Marantz had given Opsodis the opportunity to talk to the press and demonstrate, to get feedback. The Opsodis team, including Chief Technical Officer Takashi Takeuchi, clearly surprised Marantz by announcing that Marantz would "launch during next year", that "many AV manufacturers will join this sound revolution", and "Marantz will lead the move".

During a hard-to-understand description of the complex theory behind the system, Opsodis claimed "natural sound quality anywhere in a room ... with minimal manipulation" and even quoted a price – Eu 2500 for a "lifestyle" system including a Marantz amplifier with built-in Opsodis processor and front speaker units.

### Effective Demo – in Part

Demonstrations were given to groups of only five journalists at a time sitting in the room centre, in front of a plasma screen and three bookshelf speakers laying on their sides like small coffins. The centre speaker has two tweeters (left and right) and two mid-range units (left and right); there are two bass drivers in each of two outer cabinets. The walls of the room were damped to show that the system did not rely on wall reflections.

A demonstration recording of frogs at the front and thunder at the rear was remarkably effective, and excerpts from martial arts fantasy *House of Flying Daggers* sent fight and drum effects wafting round the room. But a recording of a car driving away gave an image which was hard to locate. My/our request to hear music through the system was refused. "We have not prepared any music" said Takeuchi.

He also explained that the use of eight drivers at a spread of different horizontal positions was necessary because different frequencies should come from different directions. "I would prefer more driver units – ideally an infinite number" said Takeuchi.

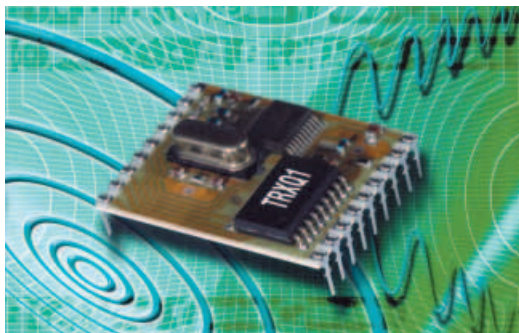
Marantz staff said afterwards that they would only be interested in selling the system as a way to create pseudo surround from a lifestyle AV package, with a single small and stylish speaker unit at the front – not three large front boxes that users may well find more intrusive than small satellite speakers around the room. Terrie O'Connell, MD of Marantz Europe, stressed that – despite what Opsodis was saying – Marantz is not yet committed to a launch in the form demonstrated.



# Smart Radio

RF Solutions have introduced a new intelligent modem FM narrow-band transceiver. TRXQ1 is their latest "Smart Radio" that greatly simplifies the implementation of reliable wireless communications. An RF transceiver-only version, the RXQ1 is also available.

The modules are able to achieve data transfer at up to 20K Baud with a range of up to 200 metres. The TRXQ1 incorporates all the functions of a complete radio modem and simply requires CMOS/TTL data at its transmitting input. A serial data interface with handshake and on-board 190-byte buffer are included. Both modules can operate at either 433-92MHz or 434-33MHz and are crystal controlled. Performance is



also enhanced by excellent interference rejection. They operate at 3V to 5V.

For more information contact RF Solutions, Dept EPE, Unit 21, Cliffe Industrial Estate, South Street, Lewes, E.Sussex BN8 6JL. Tel: 01273 898000. Fax: 01273 480661. Email: [sales@rfsolutions.co.uk](mailto:sales@rfsolutions.co.uk). Web: [www.rfsolutions.co.uk](http://www.rfsolutions.co.uk).

## CONRAD'S COMPONENTS

We are pleased to welcome Conrad-Direct as an advertiser in *EPE*. Conrad offer a wide variety of electronics components and equipment, "from power supplies and components to circuits and accessories".

Max Conrad founded the company in Germany in 1923, aiming to provide his customers with everything they needed to listen to the radio – a newly-introduced feature at that time. Conrad's first catalogue was introduced in 1936.

Conrad-Direct are currently also in Austria, France, Eastern Europe and now the UK. They supply their products to customers in more than 150 countries world-wide.

In Conrad's first advert with us (see elsewhere in this issue), you can obtain a discount of 10% off orders valued at £30 or more. You'll also get the chance to win a Voltcraft Multimeter worth £139 in Conrad's Prize Draw!

To find out more about Conrad, browse [www.conrad-direct.co.uk](http://www.conrad-direct.co.uk).

## 'Ear 'Ear!

Well, we really have to agree with the press release we've received from Bim Bam Banana – their Politician's Ear Piece "alarm is probably one of the most ingenious gadgets for people who nap and fall asleep when they are, for example, driving, at a meeting, watching TV/video!"

The alarm sits on your ear and works as a spirit level. When you start nodding, it starts hooting and wakes you up immediately (and presumably those alongside you too – can't be bad!)

For \$36 US, you can buy this astonishing insomnia inducer, and other "latest gadgets, fantastic innovations, funny gizmos and cool novelties" at the e-shop [www.bimbambanana.com](http://www.bimbambanana.com), or you can find out more by emailing [sales@bimbambanana.com](mailto:sales@bimbambanana.com) (mention *EPE*).

## Gi's a Job!

*An interesting press release has come in about CVmailer.com, "an innovation for finding work in electronics".*

*CVmailer is said to provide far more benefits at a quarter of the price charged elsewhere. The software is free to download and try, so the job seeker can evaluate the product before making a decision. Just by selecting "Electronics" and a geographical location, the user gets CVmailer to compose a fully amendable cover letter, personalised and sent with the CV to a named contact at an agency.*

*The database lists hundreds of agencies and the job seeker can choose how many they want to contact. Carefully vetted recruiters are added and categorised daily.*

*CVmailer is easy to use, taking an average of 10 minutes to complete the process. It works on all versions of Microsoft Outlook and Outlook Express.*

*For more information browse [www.CVmailer.com](http://www.CVmailer.com) or email [enquire@cvmailer.com](mailto:enquire@cvmailer.com) (mention *EPE*).*

## Jack Kilby Dies

Jack Kilby, a retired engineer with Texas Instruments who invented the integrated circuit, died on 20 June 2005 in Dallas. He was 81.

Jack St. Clair Kilby invented the first monolithic i.c., which was to become the foundation for modern microelectronics, resulting in the world of miniaturization and integration that we know today. He was awarded the Nobel Prize in Physics in 2000 for his role in the invention of the i.c.

TI chairman Tom Engibous said, "If there was ever a seminal invention that transformed not only our industry but our world, it was Jack's invention of the first integrated circuit."

Kilby joined TI in 1958, and invented the i.c. that year, apparently while many of his colleagues were on holiday! Kilby and

## USB PIC Programmer

Microchip has announced its PICkit 2 Starter Kit. This is a PIC development and experimentation module for use with PC's having a USB connection, and operating at full-speed USB 2.0. It does not require a separate power supply.

PICkit 2 comes with a set of easy-to-understand tutorials. In addition, it can easily plug into development boards via ICSP (In Circuit Serial Programming).

For more information browse [www.microchip.com/tools](http://www.microchip.com/tools).

## Rapid's New Products

Rapid Electronics have sent us their *Summer Edition of New Products*. In this edition you will find a wide range of product introductions from leading suppliers such as Weller, Flinder and Varta for instance. Rapid say that "your feedback has helped us to analyse your requirements, removing the products you don't want and introducing the ones you do."

Rapid's product portfolio now extends to well over 32,000 tried and tested lines, which are constantly reviewed, refocused and extended.

For more information contact Rapid Electronics Ltd, Severalls Lane, Colchester, Essex CO4 5JS. Tel: 01206 751166. Fax: 01206 751188. Email: [sales@rapidelec.co.uk](mailto:sales@rapidelec.co.uk).

Web: [www.rapidelectronics.co.uk](http://www.rapidelectronics.co.uk).

## MERG

The Model Electronic Railway Group (MERG) have written to thank us for our last mention of them, and to send their latest newsletter. We feel it's good to mention MERG again now because of John Waller's *Controlling Model Railway Signals* article in this issue. John actually joined MERG following our telling him about the group.

So if you're into model railways, anywhere in the world, why not find out more about MERG, browsing [www.merg.org.uk](http://www.merg.org.uk).

TI officials put the first circuit to the test on 12 September 1958, with success. In 1960, TI announced the first chips for customer evaluation. Two years later, TI won its first major i.c. contract to design and build a family of 22 special circuits for the *Minuteman* missile.

Kilby officially retired from TI in 1983, but he continued to do consulting work with the company. He held more than 60 patents for a variety of electronics inventions. Among them were the handheld electronic calculator and the thermal printer, both of which he co-invented. In addition to the Nobel Prize, he received numerous honours and awards for his contributions to science, technology and the electronics industry.

At the time of writing, a report can be read at [www.reed-electronics.com/electronicnews/article/CA609808?nid=2019](http://www.reed-electronics.com/electronicnews/article/CA609808?nid=2019)

# Multicore Cable Tester

David Geary

Solving one of life's mysteries – how to conveniently check lengthy multicore cables

**T**HE number of fairly complex multicore cables in the home and the workshop is steadily increasing. The workshop PC brings with it a printer, keyboard, mouse and monitor, possibly a network connection and probably a modem line. All of these items require a dedicated connector and a multicore cable to connect it all together.

Buying commercially-made leads can be expensive, and even then, you may not be able to get exactly what you require and have to manufacture your own; with the attendant doubt that all is wired, and wired correctly! Testing these leads can be confusing, especially if there are several to make up of the same type.

Commercially manufactured leads are just as prone to damage, kinking, and connector failure as those we make ourselves, and if you count up the number of leads that surround us in the home and at work, the result can be quite surprising.

## Design Motive

The idea for this Multicore Cable Tester arose from the author's apparent new responsibility for an Ethernet network at his place of work. On changing a network hub, one leg of the network stopped working. All other cables plugged to the new hub worked fine, except for one.

As to be expected, the cable in question ran across a false ceiling, down a riser cupboard, under a raised access floor and into a presentation lecturn; therefore changing it to see if that solved the problem was not to be lightly considered! The cable was 15 metres long and checking with a multimeter was simply not an easy option.

This tester allows easy identification and testing of multicore cables in a variety of situations so long as at least two cores are connected. It offers quicker testing than traditional continuity methods, using i.e.d. indication and sound to check continuity and correct connections in cables. There is

also a "quick check" for crossover wired cables.

The unit is designed to test cables having up to eight cores, with cables having more than eight conductors being split into groups of tests. However, eight cores is sufficient for most, including:

- 1 Ethernet cables
- 1 Audio cables
- 1 SCART leads
- 1 Keyboard and mouse extension leads
- 1 Computer monitor cables
- 1 Modem/serial leads
- 1 USB cables, etc.

### The unit will:

- 1 Identify a cable
- 1 Check continuity of all cores
- 1 Identify a "crossover" type cable

All that is required is the right connector for the cable under test.

## Cable Types

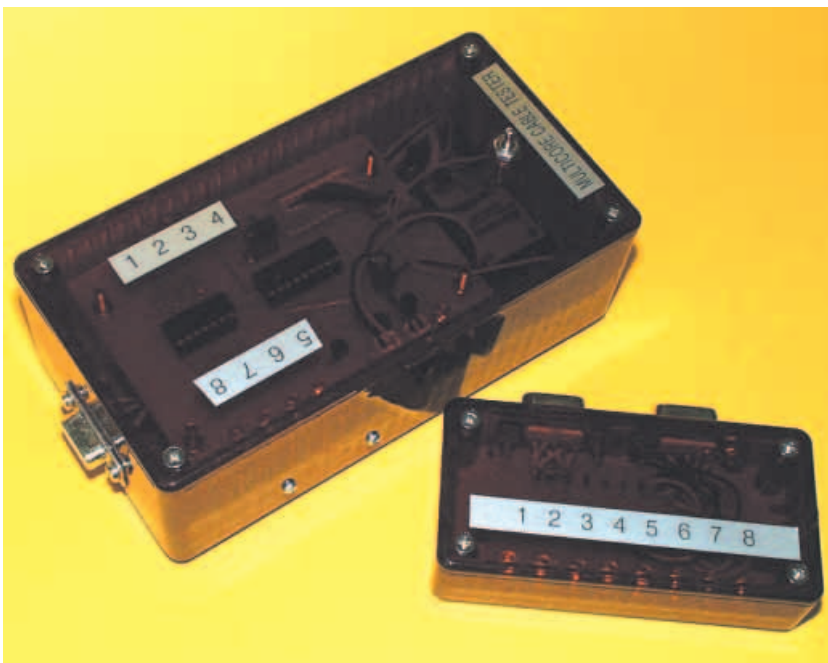
The tester uses relatively low switching rates and employs a software delay to allow settling time from a sharp squarewave test signal and the consequent capacitive delay. There is therefore considerable flexibility in the uses of the device, limited only by the connectors installed by the user.

As an alternative, it is probably easiest and quickest to build the tester and passive/active sockets using 9-pin D-connectors and then make suitable adaptors for each use. Some suggestions are discussed later but there is really no limit to the adaptors that could be made.

## Design Overview

Referring to the main Multicore Cable Tester circuit diagram in Fig.1, this design uses a PIC16F84 microcontroller (IC1) for the testing operations and a 74HC164 shift register (IC2) to output the i.e.d. display.

The cable leads to be tested are connected to the PIC's Port B via connector SK1.



The completed Master tester and the small Active/Passive socket that combine to make up the Multicore Cable Tester





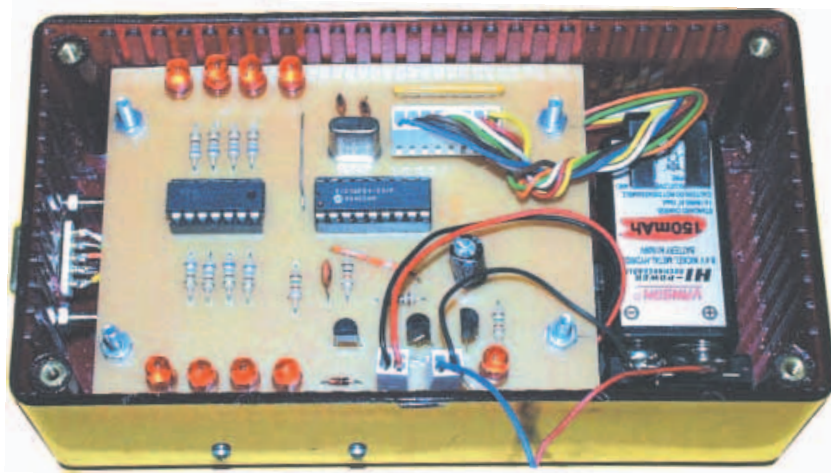
The PIC takes each of the eight cores “high” in turn, in each case configuring the other seven pins on Port B as inputs. A delay is built in to prevent cable capacitance giving erroneous readings. Port B is biased normally-low by resistors R5 to R10, within a s.i.l. (single-in-line) package.

The results of the eight tests are ORed together and the tests re-run to ensure that the results are complete – it is always possible, indeed likely, that a cable could be plugged in halfway through a sequence.

When any combination of connected cores is found, the results are serially fed to the shift register (IC2) by Port A and displayed on eight l.e.d.s, D2 to D9, corresponding to each cable core. A “beep” subroutine then sounds the buzzer WD1 briefly for each digit, extended to a double beep for each logic 1 within the results.

The buzzer uses considerably more current than the PIC could safely drive and therefore transistor TR1 is used in conjunction with back-e.m.f. diode D1, and controlled by PIC pin RA3. The buzzer is a low cost model and the type is not critical. Using TR1 also allows the buzzer to be fed “pre-regulator”, from the 9V line.

Finally, a Crossover test routine takes four pins of Port B high and tests the other half. A “go/no go” test here indicates the polarity of the cable and the Port A l.e.d.



General component layout inside the Master unit

D10 is activated accordingly via transistor TR2, which is controlled by PIC pin RA4. Resistor R3 pulls this “open-collector” pin normally high.

The unit is powered by a 9V battery, B1, with regulator IC3 reducing the voltage to 5V to suit IC1 and IC2. The battery type is not critical (the prototype uses a rechargeable PP3-type).

The PIC is crystal controlled (X1). The crystal frequency should not be critical although others have not been tried.

Resistor R1 and capacitor C1 provide power on reset.

Shift register IC2 is specified as an HC type, which has excellent current drive capabilities. Ordinary 5mm red l.e.d.s are used with simple current limiting resistors R13 to R20.

## Passive Socket

Both ends of the cable under test must, of course, be connected in some way. The simplest technique is to use a passive “shorting” connector at the far end, such as shown in Fig.2a.

The wiring for the passive socket, though, depends on your final use. If using 9-pin D-type connectors follow Fig.2a. For Ethernet cable testing, however, wire SK2 so that pins 5, 6, 7 and 8 are connected as one group, with pins 1, 2, 3, 4 connected as the other, then connect diode D11 between pins 6 and 3, anode to pin 6.

The principle is to isolate pins into two halves which are reversed with a cross-wired cable, and place the diode between the two halves. Reversing the diode reverses the action of the crosswire l.e.d., D10.

Additional passive sockets can be easily made up using the same principles for other applications.

## Active Socket

An alternative for the “far end” is to use an “active socket” technique, as shown in Fig.2b. Here additional l.e.d.s. (D12 to D19) indicate the status of each core connection, so checking not just that up to eight cores are connected, but also that they are all connected correctly.

Resistor R21 buffers the l.e.d.s., and diode D20 to D27 matrix the circuit to suit the software control.

This unit mirrors the lamp test function so by turning the main tester off and then on again, the sequence of l.e.d.s on both the tester and the active socket should light in order. This clearly identifies incorrect or correct connections, and confirms cross-connected cables.

## Construction

Details of the printed circuit board component and track layouts for the Master and Active units are shown in Fig.3 and Fig.4. These boards are available from the *EPE PCB Service*, codes 525 and 526.

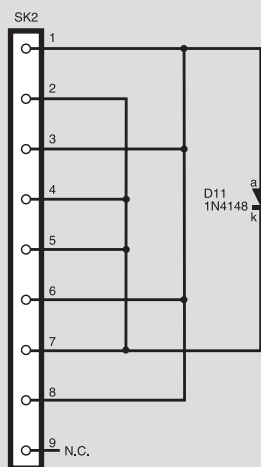


Fig.2a. Passive circuit arrangement – see text

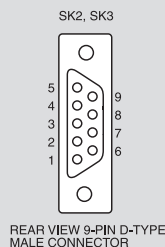
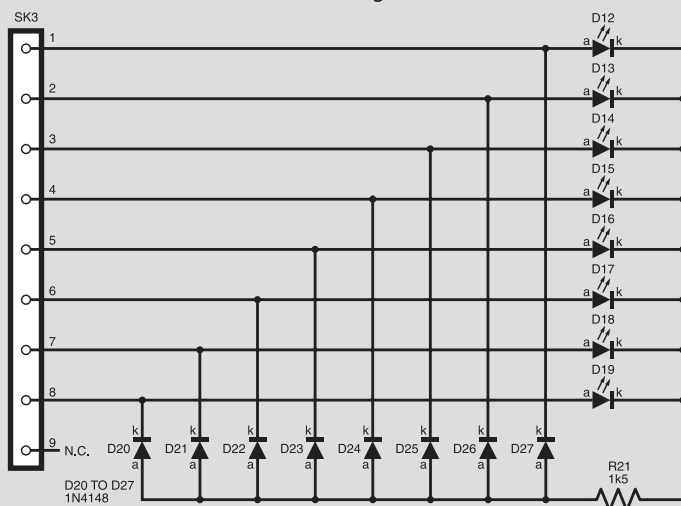


Fig.2b(below). Active socket circuit arrangement – see text





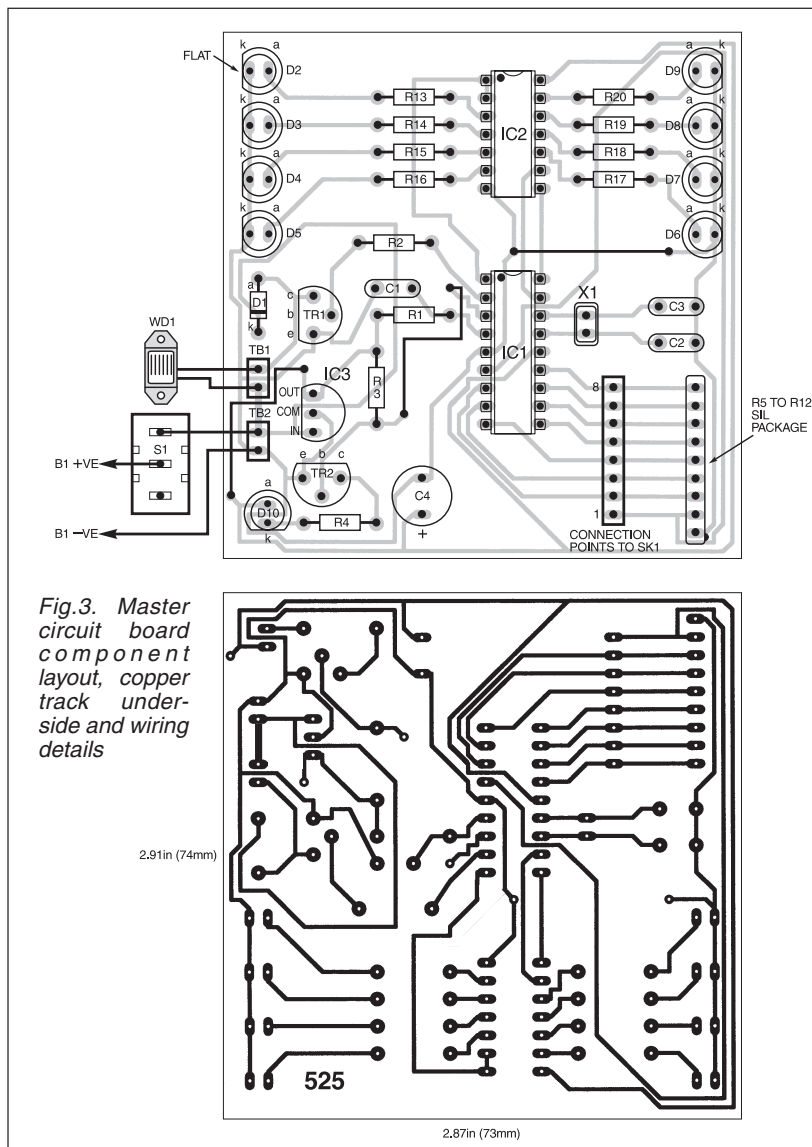


Fig.3. Master circuit board component layout, copper track underside and wiring details

Whilst the circuits are simple, with a project of this nature care is needed with off-board wiring to get correct results from the finished tester. Fit i.c. sockets and connectors first, followed by resistors, then capacitors, then semiconductors. The use of p.c.b. connectors is strongly recommended, although the off-board leads can be hard-wired.

The prototype used small red translucent cases, which allow the l.e.d.s to shine through the case, eliminating the need to drill holes. Take care to make sure that both p.c.b.s are correctly wired to the connectors.

On the cases the l.e.d. positions should be numbered 1 to 8, to correspond with the 9-pin D-type connector pin numbers.

Once the board has been assembled, carefully drill holes for the buzzer, cable connector(s) and switch and wire these to the p.c.b. connectors. Final assembly then becomes a simple case of plugging everything together.

In 9-pin serial leads, pin 9 is not normally used, so the wiring becomes simply pin 1 to pin 1, etc, as marked on the rear of the D-type connectors. Given the possible repeat interwiring of sockets it is useful to adopt a standard colour wiring code throughout the project.

Care is required to ensure that the correct pins from the PIC are connected to the correct pins on the socket, and therefore the cable.

## Testing

Without connecting a cable, and after a physical inspection that all is well, switch on. The unit now goes through a self-test routine to check that all l.e.d.s and the internal buzzer are working. The lamp and buzzer test should operate – a moving l.e.d. display and eight beeps. The crossover l.e.d. D10 will light as a power-on indicator. This self-test is later used for checking correct connections in the cable under test.

Prototype Active/Passive socket unit

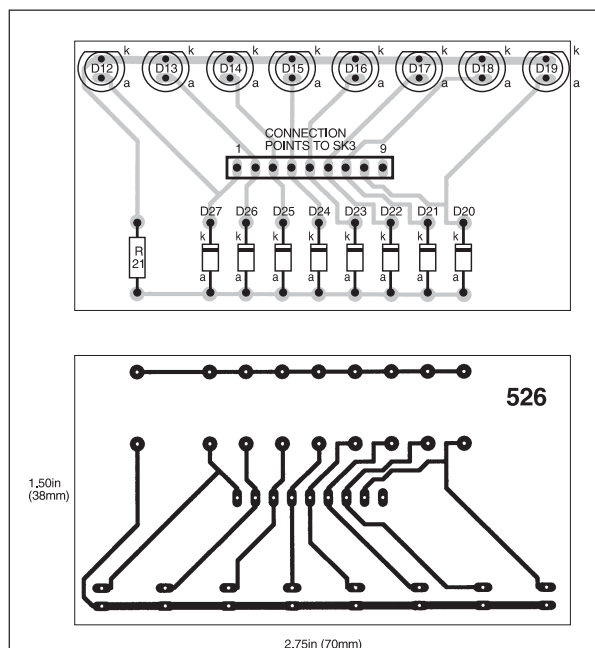


fig.4. Active "socket" printed circuit board details

Plug a straight-through lead into the master unit's socket SK1. Nothing should happen – yet! Plug the other end of the lead into the passive socket, SK2, of the “far end” unit. You should immediately hear a series of eight beeps, a short one for each unconnected core and a long beep for each connected core. An l.e.d. should be lit for each connected core.

Switch off and on again with the cable plugged in for the most accurate and reliable display without plug-to-socket contact bounce.

## In Use

In use, one end of the cable is plugged into the master unit, and the other end into the slave (passive) socket. As soon as the cable is connected, the buzzer will sound eight beeps, longer beeps for each connected core. The 8-wide l.e.d. display will turn on a corresponding l.e.d. for each core. The l.e.d. display indicates which cores are connected and which are not in one operation, however, to eliminate the effects of plug-in contact bounce, switch the unit off and then on to retest the cable.

An audible indication is ideal for identifying “which is which” when wiring Ethernet cables or other situations where there are a number of similar cables – plug the end of the cable you are trying to find into the master unit, and (we’ve all been there!), crawl under the desk with the passive socket trying each in turn. When you hear the buzzer, you’ve found it; this is certainly better than the “sharp tug and see if it moves” method!

If the cable is a “crossover” type, a ninth l.e.d. on the main unit (D10) will light after the eight beeps are finished.

Once a cable is detected, unplugging the cable at either end resets the tester to detect another cable so there is no need to switch the tester on and off between operations (other than for contact bounce elimination). The l.e.d. display always shows the last results.

## Checking Correct Connections

If the “active” slave socket (SK3) is used, the power on self-test can check the correct connections. The active socket has eight l.e.d.s which can be numbered exactly as for the master unit. On power on, each l.e.d. on the master unit lights and a short beep is heard. Therefore, if a note is made of which l.e.d. lights on the active socket in order, it is simple to establish the connection sequence. For example, testing a modem lead was carried out as follows.

Firstly, the passive socket was connected to one end and the other plugged into the main unit. Switching the tester on, the power up sequence completed in a few seconds, followed by seven of the eight l.e.d.s being lit, with one short beep and seven long beeps. This indicated, correctly, that pin 1 was unused and that the subsequent seven were connected. At the end of the eight beeps, the crossover l.e.d. lit, indicating that this lead was a crossover type.

Secondly, the passive socket was swapped for the active socket. Taking a piece of paper, and numbering from one to eight from top to bottom, the tester was switched off and then on again. Writing down which l.e.d. lit after each beep during the startup sequence gave the following results:

Main	Active
1	None
2	3
3	2
4	6
5	5
6	4
7	8
8	7

Table 1

Pin	Crossover Highlight	A - First Time	A - Rearranged	B - First Time	C - First Time
1		1	2		
2		2	1		
3		3	3		
4		4	4		
5		5	6		
6		6	5		
7		7		1	
8		8		2	
9				3	
10				4	
11				5	
12				6	
13				7	
14				8	
15					1
16					2
17					3
18					4
19			8		
20			7		
21					5

Table 2

Core	A Results - LED Display	Active Socket		Core	Active Socket
1	On (fully wired)	2		2	1
2	On (fully wired)	1		1	2
3	On (fully wired)	6		6	3
4	On (fully wired)	4	rearranging	4	4
5	On (fully wired)	5		5	5
6	On (fully wired)	3		3	6
7	On (fully wired)	8		8	7
8	On (fully wired)	7		7	8
from <i>Scart</i> diagram		xover lead			xover lead
On self test, LED's on the active socket should light in the order 2,1,6,4,5,3,8,7					

Table 3

Core	B Results - LED Display	Active Socket		Core	Active Socket
1	On (fully wired)	1		1	1
2	On (fully wired)	2		2	2
3	On (fully wired)	3		3	3
4	On (fully wired)	4	no rearrange necessary	4	4
5	On (fully wired)	5		5	5
6	On (fully wired)	6		6	6
7	On (fully wired)	7		7	7
8	On (fully wired)	8		8	8
from <i>Scart</i> diagram		xover lead			xover lead
On self test, LED's on the active socket should light in the order 1,2,3,4,5,6,7,8					

Table 4

Core	C Results - LED Display	Active Socket		Core	Active Socket
1	On (fully wired)	1		1	1
2	On (fully wired)	2		2	2
3	On (fully wired)	3		3	3
4	On (fully wired)	4	no rearrange necessary	4	4
5	On (fully wired)	5		5	5
6	On (fully wired)	N/C		N/C	N/C
7	On (fully wired)	N/C		N/C	N/C
8	On (fully wired)	N/C		N/C	N/C
from <i>Scart</i> diagram		xover lead			xover lead

From this, pin pairs 2/3, 4/6 and 7/8 are swapped but pin 5 remains pin 5 at each end.

## Making Up Adaptors

The following information might be useful for those wishing to use the unit for other common cables.

In order to preserve the crossover function it is useful to adopt a procedure for



working out pin connections. There are two groups of pins on D-type connectors:

- Group A: 1, 3, 6, 8  
Group B: 2, 4, 5, 7

In designing an adaptor for a cable that has a crossover variant, assign either A or B to each group of pins that may get crossed, then substitute the pin numbers above. If there is no crossover variant, or for the pins that are never crossed, the assignment is irrelevant.

The principle is that for crossover detection to work, you must ensure that all pairs of pins that may be crossed have one pin "either side" of the detection diode (D11 in Fig.2a). The following instructions are intended to help design an adaptor for any type of lead, and make interpretation of the results easier.

Referring to Table 1:

1. List down the left hand side of the page the pin numbers in the connector of the cable to be tested

2. Check which pairs would be reversed in a crossover lead, highlighting each pair perhaps in a different colour highlighting pen

3. Using digits in the range 1 to 8, list in the next column the connections you will make to the Multicore Cable Tester

4. Swap the second column around so that for each pair that might be reversed in the lead, one is connected either side of the detection diode, i.e. one core from each group above (A or B) in each pair

When you run the test, you will get different active l.e.d.s on the Main unit and the Active socket if the cable is crosswired. If you "read back" the l.e.d. number on either display from your second column to the first column, you will be able to see which pins are connected in the end of the cable nearest the display you are reading.

## SCART

Tables 1 to 5 show how to make a SCART lead tester. Many cheap leads only make the essential connections, which are all within "Adaptor A".

There are 21 pins for a SCART cable, so to fully test it requires three 9-pin D-type connectors – effectively three adaptors in one. Remember you therefore need two SCART connectors and six 9-pin D-type connectors in total (one for the main unit, same again at the slave end). In the tables the three adaptors are labelled A, B, and C.

Tables 2 to 4 calculate the results of power on self-test, and come from examination of a SCART wiring diagram (see web links later).

The crossover version is the one most used. The pins on the SCART connector are already marked, so a suggested wiring table would be that in Table 5.

Crossover indication only works with adaptor A. The active socket will run in sequence, i.e. its l.e.d.s 1 to 8 (D12 to D19) with the main unit's l.e.d.s (D2 to D9) for adaptors B and C, confirming the crossover in the case of adaptor A.

## Audio Leads

Testing audio leads is simply a case of assigning pins, as the only crossover (or mirror-image) tends to be with DIN leads.

**Table 5**  
9 pin D connector wiring in each case

SCART	A	B	C
1	2		
2	1		
3	3		
4	4		
5	6		
6	5		
7		1	
8		2	
9		3	
10		4	
11		5	
12		6	
13		7	
14		8	
15			1
16			2
17			3
18			4
19	8		
20	7		
21			5

In the case of a 5-pin DIN connector, use Table 6

## Keyboard and Mouse Leads

There are no crossover variants with keyboard and mouse leads, which are typically 6-pin mini DIN. Therefore pin assignments can be simply those in Table 7.

## VGA Monitor Leads

There are no crossover variants for VGA monitor leads, which are 15-pin, as shown in Table 8.

## USB Leads

Again, there are no crossover variants of USB leads, which are as given in Table 9.

## Expansion

For one copy of the prototype, the unit's use was expanded to network cables by installing an RJ45 socket connector in parallel with the 9-pin D-type connector. This enabled the testing of Ethernet cables without a made up adaptor, and still allowed adaptors to be easily and quickly made up to suit other applications. There is no technical reason not to add additional sockets of varying types to the unit, other than the need to keep wiring tidy.

It is remarkably difficult to obtain panel mounting RJ45 sockets, so the prototype used a component which mounts in a conventional-size accessory plate. The RJ45 standard has eight cores, and while getting access to these is easy (thanks to IDC connections on the socket), the layout of these is far from obvious.

The rear connections of the socket used in the prototype relative to the pin connections of the cable, and viewing the socket from behind, the top line order is 7, 8, 5 and 4. For the lower line the order is 6, 3, 2 and 1. The shutter pulls down to this end from above, i.e. the label is below the socket.

Note that RJ45 patch leads for 10mb/s and 100mb/s only need four of the eight cores, but those for 1000mb/s need all eight. Therefore four connected cores may be sufficient – cores 1, 2, 3 and 6.

## Conclusion

The tester has become part of the author's armoury, particularly for moving

Table 6	
DIN	9 pin D
1	1
2	2
3	3
4	6
5	4

Table 7	
6 pin DIN	9 pin D
1	1
2	2
3	3
4	4
5	5
6	6

Table 8	
VGA	9 pin D
1	1
2	2
3	3
4	–
5	4
6	5
7	6
8	6 (generally commoned in equipment with pins 6,7)
9	–
10	4 (generally commoned with pin 5)
11	–
12	–
13	7
14	8
15	–

Table 9	
USB	9 pin D
1	1
2	2
3	3
4	4
Shield	5

PCs around the work environment, identifying network patch leads from each other and making sure cross-wired cables are easily identified. It is a quick and easy tool to use and can even be used as a "core number" identifier for telephone cables, etc, using just a crocodile clip connection. The possibilities are endless!

## Resources

Software, including source code files, for the PIC unit and PC interface is available on 3.5inch disk from the Editorial office (a small handling charge applies – see the *EPE PCB Service* page) or it can be downloaded free from the *EPE Downloads* site, accessible via the home page at [www.epemag.co.uk](http://www.epemag.co.uk). It is held in the PICs folder, under Cabletest. Download all the files within that folder.

Some useful websites for those making up their own adaptors:

[www.netspec.com/helpdesk/wiredoc.html](http://www.netspec.com/helpdesk/wiredoc.html)  
[www.ertyu.org/~steven\\_nikkel/ethernet\\_cables.html](http://www.ertyu.org/~steven_nikkel/ethernet_cables.html)  
[www.physiol.ox.ac.uk/~trp/pinouts.html](http://www.physiol.ox.ac.uk/~trp/pinouts.html)  
[www.leadsdirect.f9.co.uk/scart.htm](http://www.leadsdirect.f9.co.uk/scart.htm)  
[http://homepage.ntlworld.com/another\\_world/scart.htm](http://homepage.ntlworld.com/another_world/scart.htm)

# Ingenuity Unlimited

## WIN A PICO PC BASED OSCILLOSCOPE WORTH £586

- 5GS/s Dual Channel Storage Oscilloscope
- 50MHz Spectrum Analyser
- Multimeter
- Frequency Meter
- USB Interface.



If you have a novel circuit idea which would be of use to other readers then a Pico Technology PC-based oscilloscope could be yours. Every 12 months, Pico Technology will be awarding a PicoScope 3205 digital storage oscilloscope for the best IU submission. In addition a DrDAQ Data Logger/Scope worth £59 will be presented to the runner up.

Our regular round-up of readers' own circuits. We pay between £10 and £50 for all material published, depending on length and technical merit. We're

looking for novel applications and circuit designs, not simply mechanical, electrical or software ideas. Ideas *must be the reader's own work and must not have been published or submitted for publication elsewhere*. The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should be typed or word-processed, with a brief circuit description (between 100 and 500 words maximum) and include a full circuit diagram showing all component values. **Please draw all circuit schematics as clearly as possible.** Send your circuit ideas to: *Ingenuity Unlimited*, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. (We **do not** accept submissions for IU via email). Your ideas could earn you some cash **and a prize!**



## Low-Cost RS232 Interface – *On The Face Of It*

**S**ERIAL PC interfaces are appearing on more and more constructional projects these days, and most will use the ubiquitous MAX232 or similar i.c. to convert between the RS232 and microcontroller voltage levels.

The RS232 requires a voltage of at least +3V for a logic '0' and -3V for a logic '1'. Measuring the output of several PC's, including older desktops and modern laptops shows that the actual output varies enormously, from +/-5V to +/-12V.

A microcontroller circuit has no problem generating +3V to +5V since this is often the supply voltage; negative voltages are however not normally available. The simple circuit diagram shown in Fig.1 can be used to "highjack" the required negative supply voltage from the PC's interface, and provide the signal buffer and inversion required.

The circuit relies on the fact that the TX output signal from a PC spends most of its time at the negative voltage level. Although this circuit is not smaller than an equivalent MAX232 the placement of components is not critical so it may be easy to place and route on a p.c.b.

Diode D1 and capacitor C1 implement the negative voltage reference for the circuit, driven by the negative cycles of the TX pin. This allows transistor TR2 to swing between +5V and whatever negative voltage the PC is using.

The logic signals from the microcontroller must be inverted to match RS232 signal polarities, and this is implemented by transistors TR1 and TR2. Diode D2 stops TR1 becoming reversed biased by the TX signal. As TR1 will be saturated when turned on, resistor R4 helps to turn it off quickly on a negative cycle.

Terminal block TB1 connects to the PC's serial port, and TB2 connects to the microcontroller circuit. It can, of course, be integrated directly onto the project circuit board.

The circuit has been found to work successfully at data rates up to 115200 with a 1.5M cable.

None of the components are critical. Any small signal *nnp/pnp* transistors should do, and the diodes could be replaced with 1N4148s or similar.

The reservoir capacitor C1 could be larger, so long as a working voltage of 35V or greater is used.

*Mike Hibbett,  
Chatham, Kent*

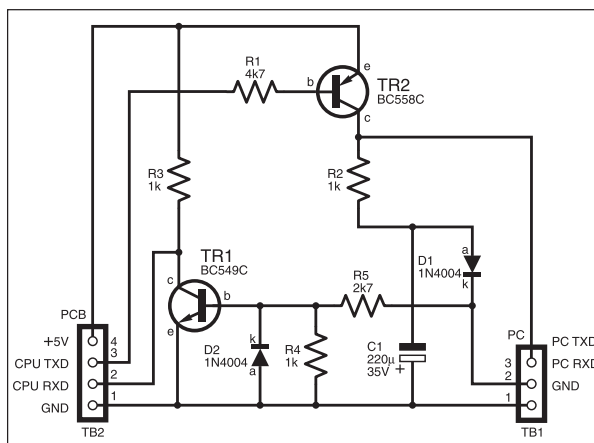


Fig.1. Circuit diagram for the Low-Cost RS232 Interface

## TV Audio Coupler – *Sound Sense*

**H**AVING recently purchased a new TV with an inbuilt cinema sound decoder, I was disappointed to find that it was configured to only provide the full "Dolby" effect when used with its own extension speakers. I needed a way to use the provided extension speakers at the rear, but derive an audio signal controlled by the TV remote for the front to use my existing Hi-Fi amplifier and speakers. The alternative was yet more speakers (my wife was not impressed) in our room.

The circuit diagram Fig.2 provides a dummy load (R1/R2 and R3/R4) of 9.4 ohms to 20W maximum dissipation. The miniature, specified transformer has a d.c. primary resistance of 660 ohms, which being high compared with the series resistance of R1/R2, R3/R4, will mean that the worst case power dissipation in the transformer primary will be minimal. In practice, the added inductance at audio frequencies will reduce dissipation still further.

The use of a transformer eliminates any possibility of "ground loops" or falling foul of "bridge output" configurations in commercial equipment, where accidentally grounding either side of a loudspeaker output could cause internal damage. The transformer is, of course, an inductive load but so are the loudspeakers that are intended to be used!

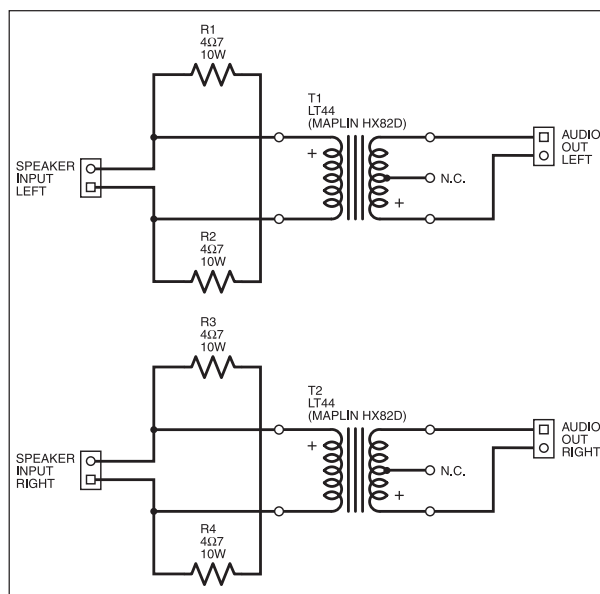


Fig.2. TV Audio Coupler circuit diagram

In practice the centre tap of the secondary was not required, but would provide a 50% attenuation if necessary. This very simple solution appears to work extremely well, fooling the TV electronics into

thinking speakers are connected, and does not require a power supply!

*David Geary,  
Blackheath, London.*

## PIC-Based Noise Generation – *Logically Inverted Silence*

**I**N the good old heyday of electronic music and disco sirens, electronics enthusiasts would experiment with different circuits to produce strange hissing sounds, or "white" and "pink" noise, as it became known. Applications included music keyboards, drum machines and even "realistic steam noise" for model railways.

One trick for making "digital noise" involved networks of shift registers and exclusive-OR (XOR) gates. Nowadays, you can do the job much more quickly using a PIC and applications for this technique can be found in many designs, including test equipment, electronic games, encryption and, yes – model railways!

By way of example, here is an 11-line (device independent) PIC routine which produces an 18,23 PRBS (pseudo random binary sequence) of "maximal length". In other words, it simulates a 23-bit shift

register with XOR feedback from outputs Q18 and Q23. For this particular set-up, the pattern of ones and zeros takes over eight million bits before it repeats itself; that's the maximum possible for a 23-bit register. Amazingly, the PIC code does this without using any XOR commands:

The code requires four registers. The output can be taken from any pin of PORTB (which contains bits Q1 to Q8 of the virtual shift register). The other three (user defined) registers are REGB (Q9 to Q16), REGC (Q17 to Q23) and TEMP which is used to perform tests on Q18 and Q23. The carry flag (STATUS,C) is used to link together the individual 8-bit registers which form the long shift register during the RLF (rotate left) operations.

The program loop repeats every 12 program cycles (the GOTO needs two cycles). However, before running the loop you **must** "seed" the contents of the virtual 23-bit shift register with a non-zero condition.

The code below, when placed in the initialisation routine, puts alternate ones and zeros into the shift register, but you can use any other non-zero seed. You could even use the contents of the PIC's EEPROM to provide a seed value which was stored during a previous use of the program.

```
MOVLW B'01010101' ; non zero seed
MOVWF PORTB
MOVWF REGB
MOVWF REGC
```

You must also set PORTB to output mode by clearing TRISB after using the appropriate bank switches for your type of PIC. (Remember to restore to Bank 0 afterwards.)

Incidentally, if you were wondering why all 24 bits are not used, it's because the maths would require the sampling of four bits from the shift register (instead of two) and this would slow down the routine.

The choice of PIC oscillator frequency will depend upon the application. A 4MHz crystal will produce a "random" output rate of 83k Baud which, when passed through a suitable low-pass filter, gives an audio noise bandwidth of around 4kHz.

If you want to use this code to test your hi-fi you will need to run your PIC at 20MHz. Perhaps you just need a random number generator for a bingo machine or to pick your Lotto numbers. The applications are endless.

*Pete Barrett, High Mickley,  
Northumberland*

LOOP	MOVF REGC,W	;	copy Q17 thru Q23
	MOVWF TEMP	;	into temp register
	BTFSC REGC,6	;	test Q23
	COMF TEMP,F	;	invert TEMP if Q23 = 1
	BCF STATUS,C	;	clear carry flag
	BTFSC TEMP,1	;	test Q18
	BSF STATUS,C	;	set carry if Q18 XOR Q23 = 1
	RLF PORTB,F	;	ripple up
	RLF REGB,F	;	all bits thru
	RLF REGC,F	;	shift reg
	GOTO LOOP		



### WHIRLYBLADES

**Wind turbines – what's your opinion of wind harvesting? Mark Nelson describes both the problems and their ingenious solutions.**

**F**EW technologies arouse more passion among normally docile people than wind turbines. The arguments for and against harvesting electricity from the wind are fairly well known but the unforeseen problems the turbines cause demand equal attention.

Wind farms and their turbines are a remarkably emotive subject. The tower clusters seen atop the mountains of Mid Wales for instance are objects of supreme grace and elegance in my view and the fact that they generate electricity for nothing is a fantastic bonus – the classic “win, win” situation.

But that's only my opinion. A recent report by the Sustainable Development Commission (SDC) notes that although there is widespread support for wind farms from an ecological point of view, there is much local resistance. People argue the noise they make is unbearable, that they spoil the landscape and they may also kill birds.

Simon Clydesdale of Greenpeace is quoted as saying, “People do support wind energy when a survey is put in front of their nose but it's a question of putting that into practice. We don't give blanket support for all wind farms, they have to be sensibly sited.”

#### Nimby Alert

Not in my back yard then. He does, however, agree that wind power is “green”, stating: “Wind power is essential to meet the government's carbon emission targets and will be one of the cheapest forms of energy out there.”

Renewable energy sources are vital to meeting the government's Kyoto target of a 12.5 per cent reduction in greenhouse gas emissions from 1990 levels, averaged over 2008 to 2012, meaning the UK must look for cleaner sources of energy. Wind farms could take this figure to 20 per cent by the year 2020.

The towers occupy very little ground space and when situated away from human occupation, any noise issues are irrelevant. The sole issues after that are the capital cost of erecting the towers and dealing with any arguments from the NIMBY brigade over visual intrusion.

There's no argument that wind farms will indeed alter the British landscape, but so did electricity transmission pylons and motorways – and the economic benefit of these is generally seen to outweigh the visual intrusion. In any case the change to the appearance of the British

countryside is likely to be far less than the dramatic effect of climate change with the shrinking coastline caused by rising sea levels and altered vegetation.

SDC chairman, Jonathon Porritt argues that climate change will have a devastating impact unless urgent action is taken to boost the contribution of renewables, alongside energy efficiency measures. So the issue is merely a matter of public education, right? Well, no. Wind farms pose a serious threat to bird migration and to aircraft radar systems, or at least they did. It's a serious problem.

#### Turbulent Times for Turbines

Urgent research is needed into the locations, numbers and movements of birds around our coasts to help us understand the potential impacts, according to the Royal Society for the Protection of Birds. Dr Mark Avery, RSPB Director of Conservation, says the government must do more to avoid major conflicts over the siting of wind farms. And although the RSPB sees climate change as the greatest threat to the world's wildlife, it does object to any wind farms that seriously threaten important populations of birds and their habitats, calling for some form of legal protection.

Bigger birds have even bigger problems. As *The Business* newspaper reported recently, significant interference is caused to the radar systems that control air traffic by the rotation of the wind turbines' blades. The radar returns or echoes tend to mimic a light aircraft. To confuse the radar further, says the report, the tip speed (although not that of the whole blade) is just below the speed of sound, much the same as an aircraft.

You might imagine that an object as static as a wind farm would not look anything like an aircraft in flight but apparently it can do. In the same way, several television repeater transmitters built by radio amateurs in the UK have had their licensing held up by the authorities, again because the picture transmissions can fool the very sensitive radar receivers.

The echoes returned by wind turbines appear as transient multiple objects that show up and vanish again. Vast flocks of migrating starlings cause the same effect from time to time and the unpredictable nature of these signals could trigger retaliatory action or the closure of an airport.

#### Fuzzy Fix

Serious problems call for serious solutions and BAe Systems (the combination of British Aerospace and Marconi Defence Systems) has come up with a solution employing fuzzy logic to minimise or even eliminate the radar interference caused by wind turbines. Fuzzy logic's approach to problems replicates the way most people come to firm decisions based more on gut feeling than pure logic by balancing out vague, ambiguous or missing input information to still reach a firm conclusion.

In this application fuzzy logic is used to find and analyse data normally hidden in a radar signal to build up a clearer profile of the object that generated the echo. Identified characteristics are then evaluated to calculate its probability of being a wind turbine. If the balance of probabilities is positive, the on-screen image is filtered to remove the object altogether.

Although the current application is for civil airport radars, the technology was first developed for military use, to distinguish aircraft from large waves and flocks of birds. At the time of writing, in-depth tests were scheduled for the end of July, to be held in Wales.

A number of RAF helicopters and Cessna light aircraft would be monitored on a Watchman radar operated by the RAF, noting these signals as well as interference from a number of wind farms in the vicinity. If the filtering software is successful only the aircraft should be visible on the radar screens, with commercial deployment likely some six to 12 months later.

#### Fears Unfounded

But what fate lies in store for our feathered friends? According to research published in the scientific journal *Biology Letters*, birds are not as stupid as we take them to be. Experts at the Danish National Environmental Research Institute have used radar to monitor bird migration patterns over the Nysted offshore wind farm on the western side of the Baltic Sea.

The verdict is that geese and ducks learn to avoid the blades, with less than one per cent of the birds found to be at risk of collision. Even at night the clever creatures kept their distance from the turbines and flew in the corridors between the structures. Finally this may be the green light for wind farms. I for one will be delighted if it is.

# Circuit Surgery

Alan Winstanley and Ian Bell



Our “surgeons” discuss low frequency amplification, looking at op.amp parameters, and offer a simple low-battery monitor

## Low Frequency Amplification

While scanning the EPE Chat Zone forum ([www.chatzones.co.uk](http://www.chatzones.co.uk)) recently the post “Amplifying <10Hz” from fellow contributor **Thomas Scarborough** caught our eye: “I’ve done a lot of circuits amplifying audio and radio, but am not as familiar with amplifying very low frequencies. I’m wanting to amplify signals in the region of 0.1Hz to 10Hz. Can you point me to anything to look at, so that I can familiarise myself better?”

Accurately amplifying low frequency signals can be surprisingly difficult, but there are special approaches that can be very effective. One of these – chopper or auto-nulling amplifiers – is this month’s *Circuit Surgery* topic. We don’t really have enough information about Thomas’s situation to know if this would be the best approach for him, but this is an interesting topic that we hope many readers will find useful.

Before we look at the solution, let’s look at the problem in more detail. A key issue with low frequency amplifiers is offset, see Fig.1. In simple terms offsets are d.c. errors, but the offsets can drift due to changes in temperature and other factors that influence the circuit. The changing offsets are just like low frequency signals that are amplified along with the signal itself – the offsets act as low frequency noise.

Assuming what we want here is some kind of op.amp with very good low frequency performance, let’s look at offsets in the context of op.amps. Ideally with a differential input (the voltage difference between the inverting and non-inverting

inputs) of zero, an op.amp’s output should also be zero, but in real op.amps there will typically be a non-zero output. The Input Offset Voltage  $V_{IO}$  is defined as the d.c. voltage which must be supplied between the inputs to force the quiescent (zero input signal) open-loop (no feedback resistors) output voltage to zero.

The input offset voltage is defined with respect to the input. The error in the output voltage due to  $V_{IO}$  is equal to the circuit gain times  $V_{IO}$  (note circuit gain, not op.amp gain). So if the datasheet quoted  $V_{IO}$  as 500mV max and your circuit had a gain of 500 you could get a 250mV (0.25V) error on the output. The temperature coefficient of input offset voltage specifies how  $V_{IO}$  changes with temperature. The datasheet for an op.amp may also have a graph showing offset variation with temperature.

Bipolar op.amps require bias (base) currents for the transistors connected to their inputs, whilst op.amps with f.e.t. inputs have leakage currents at the inputs. The Input Bias Current  $I_{IB}$  tells you how large these currents are, and is defined as the average current into the two inputs with the output at zero volts. This can vary greatly for different types of op.amp.

Bias currents flow in the external components connected to the op.amp and in doing so they cause voltage drops. If these voltage drops are not equal at the op.amp’s two inputs, they will be amplified by the op.amp and appear as errors at the output.

## A Different Bias

In practice, the bias currents are not equal so we have Input Offset Current ( $I_{IO}$ ) – the difference between the currents into the two inputs with the output at zero volts. Ideally these currents would be equal, but in practice they are not.

The input currents have to flow through the external circuitry and will cause offsets even if the impedances connected to the two inputs are equal. Of course, bias current and offset both vary with temperature so we have the temperature coefficient of input offset current which specifies how  $I_{IO}$  changes

with temperature and curves on the datasheet to show these changes.

We can also look at the problem from a noise-versus-frequency perspective. Random noise may be classed according to the frequency, or range of frequencies present. White noise has the same power throughout the frequency spectrum, whereas  $1/f$  noise decreases in proportion to frequency; both types occur in all amplifiers. It is  $1/f$  noise that causes problems when amplifying low frequencies.

How noise level varies with frequency for a typical amplifier is shown in Fig.2. At low frequencies the  $1/f$  noise dominates, but as frequency is increased we reach a point where noise level flattens out. The point at which this occurs is called the *1/f corner* and the frequencies beyond this are called the *flat band noise area*.

For audio and video amplifiers the  $1/f$  noise is not a problem as long as the  $1/f$  corner is sufficiently low (say 20Hz for audio). This can be achieved with conventional amplifiers and the unwanted lower frequencies can be blocked by capacitive coupling. From an offset perspective, offsets are simply blocked by capacitive coupling.

## Chopper Amplifiers

Chopper amplifiers can achieve lower offsets than conventional amplifiers and – crucially – much lower offset drift (e.g. one device is specified at 0.003 microvolts offset per degree temperature drift). From a noise vs. frequency perspective, choppers have a flat noise area going right down to d.c., at least in theory, completely eliminating the  $1/f$  noise (see Fig.2). On the other hand, the chopping process does introduce some extra wideband noise and some of the chopping signal may leak through to the output as indicated by the dashed peak in Fig.2.

There are a number of circuit techniques that fall under the general title of “chopper amplifier” or “auto-nulling amplifier”, but Fig.3 gives a good idea of the general approach and is the basis of a number of i.c.s available today. This circuit contains two amplifiers, the main wideband amplifier A1 that handles the signal and the

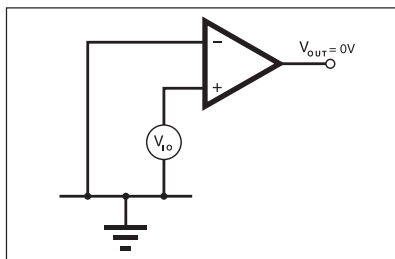


Fig.1. Offset voltage defined

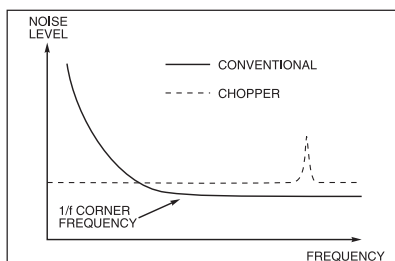


Fig.2. Amplifier noise versus frequency

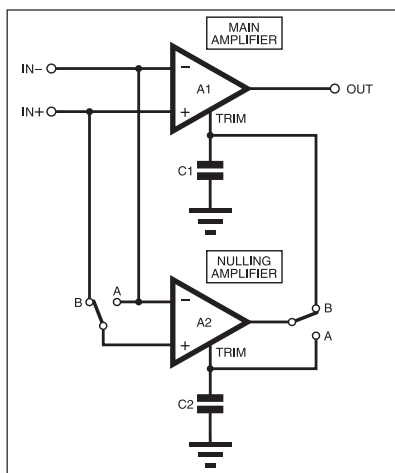


Fig.3. Chopper stabilised amplifier

nulling amplifier A2. Both amplifiers have an offset trimming input which can be used to trim off the offset. The circuit continuously switches between two phases of operation, nulling and output, under the control of a clock signal.

When the switches, which are controlled by the clock, are in the nulling position (position A on Fig.3) the inputs of A2 are shorted together and its output is connected to its own offset trim input forming a feedback loop that will null the offset. The trim voltage required to do this is stored on capacitor C2 so that it can continue to null A2's offset during the next phase. During the nulling phase the trimming voltage for A1 is held on capacitor C1.

During the output phase, the switches are in position B in Fig.3. The voltage across the inputs of the main amplifier is amplified by A2, without offset error by virtue of the trim voltage held on C2, and applied to the trim input of the main amplifier A1. The same input is also amplified directly by the main amplifier. Remember that A1 will be in an external feedback loop (e.g. the gain setting resistors of a standard op.amp amplifier). We have a more complex situation than in the nulling phase, but basically the feedback will adjust the trim voltage applied to A2 to null its offset. This voltage is held on C2 during the nulling phase, keeping A2's offset trimmed out.

Note that the main amplifier is never switched out of the signal path and is able to continuously amplify the signal. This means that amplifiers of this type can handle quite high frequencies as well as the low frequencies and d.c. that we have been focusing on (i.e. bandwidth is wide).

The main signal is not chopped; the switching action is used simply to take the

error compensation circuit out periodically to fix its own errors. The switching frequency is typically units to tens of kilohertz. There are a number of i.c.s available that are more or less based on this kind of circuit, but often with additional circuitry to compensate for imperfections in the basic approach. Next month I will look at one of those chips. *I.M.B.*

## Low Battery Indication

*"I run a small piece of self-build kit powered by a 9V battery. I would like some means of measuring when the battery voltage has fallen below some variably preset level, something like 7V. Has anyone got such a circuit with a minimum of components; say something like a resistor or two, a Zener and an l.e.d.? Kind regards, Mike Walker via email."*

The simplest way to detect a voltage reduction is probably to use a light-emitting diode that illuminates under normal conditions and fades away as the battery voltage drops. The trade-off is that it consumes a small (often negligible) amount of power that can only have a negative impact on battery life. Never-the-less, a number of battery-operated devices use such a system, including the Philips waterproof radio used in my shower!

A Zener diode, D1, with a series resistor to provide a stable voltage for a small load is shown in Fig.4. The Zener diode operates in reverse-bias mode as shown, in which case the specified Zener voltage will appear across the device when the supply voltage  $+V_s$  is sufficient. Series resistor R1 limits the current to a safe value.

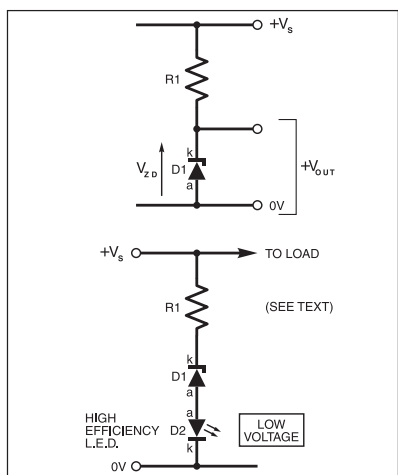


Fig.4. (a) A standard Zener diode arrangement. (b) Adding a series high-efficiency l.e.d. to act as a voltage monitor

It is desirable to have a small Zener current flowing through the device (say, 2mA to 10mA), and the heavier load current passes through the series resistor out to the load. However, when the load current reduces, then the Zener, which is classed as a shunt regulator, will "shunt" or carry the excess current away to 0V.

The operation of Zener diodes was explained in *Circuit Surgery*, November 2004 issue (back issues or reprints are available from the *EPE Online Shop* at [www.epemag.co.uk](http://www.epemag.co.uk)). When calculating

series resistances and Zener diode power ratings, it is best to think of "worst case" conditions, at maximum and minimum loads.

It is easy to use a Zener diode as part of a low-voltage monitor by adding a light-emitting diode (l.e.d.) in series across your power source, see Fig.4b. A high-efficiency l.e.d. is best, as these offer a brighter output under low current conditions. When the supply voltage is higher (say, 9V) the Zener is conductive and current flows through the l.e.d., which glows. As the supply voltage falls, the Zener will gradually cease to conduct and the l.e.d. will fade out.

The l.e.d. typically has a forward voltage of +1.8V or more when illuminated, so if you use a series 3V9 Zener diode for example, then assuming a 9V supply this leaves 3.3V to be dropped across the resistor. If we try a 5mA current then using Ohm's Law a series resistor of 3.3V / 0.005A or 660 ohms is needed (680 ohms nearest preferred value). Try a 2.2 kilohm trimmer resistor (preset) in series, set midway.

You'll need to experiment with Zener values (try some junkbox values), and as these have a poor tolerance, don't expect too great an accuracy!

You could replace the Zener with ordinary rectifiers such as the 1N4001, placed in series with the l.e.d. Each rectifier drops about +0.65V when conducting, so a handful of them wired in series will soon produce a useful voltage drop, and it may be possible to lower the current consumption a little as well.

A number of specialist integrated circuits are available that will do a good job warning of over voltage or undervoltage. One place to start is Maxim's web site ([www.maxim-ic.com](http://www.maxim-ic.com)) and search for MAX8211 or MAX8212. Their Application Note 926 shows how to use a MAX8212 to disconnect a load from e.g. a battery when the battery voltage has fallen below a certain level. *A.R.W.*

## Hanging up the Gown

Sadly this is the last *Circuit Surgery* column that I will be co-writing. I have enjoyed immensely the challenge of trying to answer your questions in a fun and non-technical way. I hope *Circuit Surgery* has encouraged readers to explore the fast-moving and challenging world of electronics and computer technology in more depth, and to pursue this worthwhile and rewarding hobby as a pastime if not career.

Like electronics technology itself, *Circuit Surgery* moves on – rest assured that this column will remain in good hands, helped along by Ian, and will appear at regular intervals for the foreseeable future. I will still be actively helping with the *EPE* web site, the *EPE Chat Zone*, developing my popular online *Basic Soldering Guide* and, of course, I shall still be writing *Net Work* – the Internet column every month, which reflects my full-time job in the Internet industry.

I have made many interesting contacts and friends along the way. My best wishes to *Circuit Surgery* readers everywhere, especially those from around the world who have been kind enough to contact me with their support and encouragement over the past dozen years. **Alan Winstanley.**



# SHOP TALK

with David Barrington

## Snooker and Darts Scoreboard

It is most important that when ordering the L293DN 16-pin half-H driver chip (also known as a stepper motor driver i.c.), used in the *Snooker and Darts Scoreboard*, that you emphasize you require one with the DN suffix. The **D** denotes it is a 16-pin device and has diode protection. Do *not* use other L293 device types as they have different characteristics and could be 20-pin versions. The one used in the prototype was purchased from **Rapid Electronics** (☎ 01206 751166 or [www.rapid-electronics.co.uk](http://www.rapid-electronics.co.uk)), code 82-0192.

The 7-stage Darlington line driver type ULN2004A was also purchased from **Rapid** (see above), code 82-0622. It is also listed by **RS** (☎ 01536 444079 or [rswww.com](http://rswww.com)), code 652-825.

Note that the PIC microcontroller must be the **PIC16F877A** version. Be aware that the software code is not compatible with the ordinary PIC16F877 device. However, notes at the end of the article show how to adapt it for the standard device.

For those readers unable to program their own PICs, programmed PIC16F877A microcontrollers can be purchased from **Magenta Electronics** (☎ 02083 565435 or [www.magenta2000.co.uk](http://www.magenta2000.co.uk)) for the inclusive price of £10 each (overseas add £1 for p&p). The software, including source code files, is available on a 3.5in. PC-compatible disk (Disk 8) from the *EPE Editorial Office* for a sum of £3 each (UK), to cover admin costs (for overseas charges see page 661). The software is also available for free download via the Downloads link on our UK website at [www.epemag.co.uk](http://www.epemag.co.uk).

The printed circuit board is available from the *EPE PCB Service*, code 530 (see page 661).

## Multicore Cable Tester

No "special" components, apart from the PIC, are called-up in the parts list for the **Multicore Cable Tester** project. If you wish to use the same translucent cases depicted in the article, these came from **Maplin** (☎ 0870 264 6000 or [www.maplin.co.uk](http://www.maplin.co.uk)). You have a choice of Infra-Red or Ice Blue and the code numbers for the "red" versions, used in the models, are N72AL (large) and N69AL (small). Blue codes are N67AL and RN32K respectively.

For those readers unable to program their own PICs, programmed PIC16F84 microcontrollers can be purchased from **Magenta Electronics** (☎ 02083 565435 or [www.magenta2000.co.uk](http://www.magenta2000.co.uk)) for the inclusive price of £5.90 each (overseas add £1 for p&p). The software, including source code files, is available on a 3.5in. PC-compatible disk (Disk 8) from the *EPE Editorial Office* for a sum of £3 each (UK), to cover admin costs (for overseas charges see page 661). The software is also available for free download via the Downloads link on our UK website at [www.epemag.co.uk](http://www.epemag.co.uk).

The two printed circuit boards are available from the *EPE PCB Service*, codes 525 (Main) and 526 (Active) – see page 661. The 9-way D-type connectors, both male and female, are now stock items from most of our components advertisers. Also, why not visit the web sites given at the end of the article for more info on cable/socket adaptors.

## All-Band Radio

Photographs of the All-Band Radio project show that the author used a polyvaricon (polythene dielectric) variable tuning capacitor. The most common "tuning" values listed for the a.m. tuners appears to be around 5pF to 126pF and 5pF to 141pF. They can usually be found listed as "transistor radio" types and are currently stocked by **ESR Components** (☎ 0191 251 4363 or [www.esr.co.uk](http://www.esr.co.uk)), code 896-110 and **Sherwood Electronics** (see page 664), code CT9.

It is important that readers purchase the unbuffered version of the 4069 CMOS hex inverting buffer i.c. This is indicated by the suffix **UB** after its type number (4069UB).

Small quantities of 30s.w.g. enamelled copper wire can be obtained from **JAB Electronic Components** (☎ 0121 682 7045 or [www.jabdog.com](http://www.jabdog.com)), mail order only.

The two printed circuit boards are available from the *EPE PCB Service*, codes 523 (Full) and 524 (Mini).

## Model Railway Signal Controller

Stepper motors should be widely available. The stepper motor, incorporating a gearbox, used by the designer in the *Model Railway Signal Controller* project came from **Jameco Electronics** of America, code 28BYJ02A. Their website is [www.jameco.com](http://www.jameco.com) and email address [international@jameco.com](mailto:international@jameco.com).

Again, many model shops should be able to offer a suitable trackside semaphore signal tower. The author's came from **Tomar Industries**, USA ([www.tomarindustries.com](http://www.tomarindustries.com)) and is the H-853 (HO scale) signal.

For those readers unable to program their own PICs, programmed PIC16F628 microcontrollers can be purchased from **Magenta Electronics** (☎ 02083 565435 or [www.magenta2000.co.uk](http://www.magenta2000.co.uk)) for the inclusive price of £4.90 each (overseas add £1 for p&p). The software, including source code files, is available on a 3.5in. PC-compatible disk (Disk 8) from the *EPE Editorial Office* for a sum of £3 each (UK), to cover admin costs (for overseas charges see page 661). The software is also available for free download via the Downloads link on our UK website at [www.epemag.co.uk](http://www.epemag.co.uk).

The printed circuit board is available from the *EPE PCB Service*, code 529 (see page 661).

## Back to Basics – Daily Reminder/Whistle Switch

We do not expect any component buying problems to be encountered when shopping for parts for this month's *Back to Basics* projects. Obviously, the choice of relay for the *Whistle Switch* will depend on the rating of the appliance being switched/controlled.

The two printed circuit boards are available from the *EPE PCB Service*, codes 527 (Daily) and 528 (Whistle).



Test and Measurement Solutions

### USB Instruments

PC Oscilloscopes & Logic Analyzers

Our range of PC Instruments may be budget priced but have a wealth of features normally only found in more expensive instrumentation. Our DS1M12 and PS40M10 oscilloscopes have sophisticated digital triggering including delayed timebase and come with our EasyScope oscilloscope / spectrum analyzer / voltage and frequency display application software and our EasyLogger data logging software. We also provide Windows DLLs and code examples for 3rd party software interfacing to our scopes. Our ANT8 and ANT18 Logic Analyzers feature 8/16 capture channels of data at a blazing 500MS/S sample rate in a compact enclosure. Detailed specifications and software downloads for these products can be found at <http://www.usb-instruments.com>

**E125**



DS1M12 "Shrimp" Oscilloscope / Spectral Analyzer

2 x 1MS/s Input Channels + waveform generator output

**E149**



PS40M10 "Shrimp" Oscilloscope / Spectral Analyzer

40MS/s sample rate  
Removable probe tip with BNC adapter

**E195**



ANT8 Logic Analyzer

16 Channels  
500MS/s max sample rate

**EasySync Ltd**

373 Scotland Street,  
Glasgow G5 8QB,  
United Kingdom

Tel: 0141 418 0181  
Fax: 0141 418 0110

Web: <http://www.easysync.co.uk>  
E-Mail: [sales@easysync.co.uk](mailto:sales@easysync.co.uk)

\* Prices shown exclude PP and VAT where applicable

# PCB-POOL®

SERVICING YOUR COMPLETE PROTOTYPE NEEDS

- Prototypes at a fraction of the cost
- Tooling and setup included
- Any contour
- Fr4 1.6mm, 35µm Cu
- Industry standard quality
- Follow up series runs
- CAM / CAD consulting

PRICE EXAMPLE:

1 EUROCARD DS-P7H  
+ Tooling  
+ Photoplots  
+ VAT

**€49**

= £ 29.89\*

\*Sterling rates may vary. Price = D 49

**FREE**

with 100 pieces  
within 1000000



Freephone  
**0800-389 8560**

Supply your own files and order ONLINE

## WWW.PCB-POOL.COM

Protel

orcad

EDWIN

GraphiCode

# Snooker and Darts Scoreboard

John Becker

Readily display all the scores at your snooker or darts matches

ONE of the interests of being *EPE's* Tech Ed is that of hearing directly from readers what they would like to see us publish in the way of constructional projects.

This Snooker and Darts Scoreboard resulted from a reader's phone call in which he asked if we had done a snooker scoreboard recently. The last one was about 15 years back – too long ago to recommend for construction now. However, browsing our "library" revealed that old design and it became apparent that it was ripe for updating. Discussing it with Editor Mike, we decided that it was worth doing, and to also add the facilities for darts scoring as well.

Needless to say, perhaps, it was a job ideally suited to a PIC microcontroller, the PIC16F877A in this instance. So, standby your cues and arrows, here it is!

## Circuit Diagram

The circuit diagram for the complete Snooker and Darts Scoreboard is shown in Fig.1. Basically, score data is entered via a  $4 \times 4$  matrixed data keypad, S1, processed to suit the game type by the PIC, IC2. The resulting data values are output to a matrixed 8-digit 7-segment l.e.d. array, X1 to X8, and an alphanumeric l.c.d. display module, X10.

The latter is for the benefit of the scorer (adjudicator). It shows, on a 2-line  $\times$  16 character per line screen, all current values for the game in progress. Its screen contrast is set by preset VR1.

The l.e.d. array, with its 2-inch (50mm) displays, is ideally suited for viewing by a small audience. Having only eight digits, its displayed data is shown in blocks selected via the keypad, as shown later in Table 1.



Data is entered via the keypad, S1, which is monitored by the PIC via Port C. Pins RC0 to RC3 are used in input mode, biased normally high by resistors R10 to R13, through which keypad column data is read. Pins RC4 to RC7 are used in output mode, being set high for the selected switch row.

The keypad software routine is a variant of that described in the author's *Using PICs With Keypads* of Jan '01. The keypad is read several thousand times a second to see if a key is pressed. When it is, the software jumps to a processing routine appropriate to that key.

Any data resulting from a keypress is stored to the PIC's memory and sent via Port A for display on the allocated section of the l.c.d. module and, as appropriate to the l.e.d. block selected, to that as well.

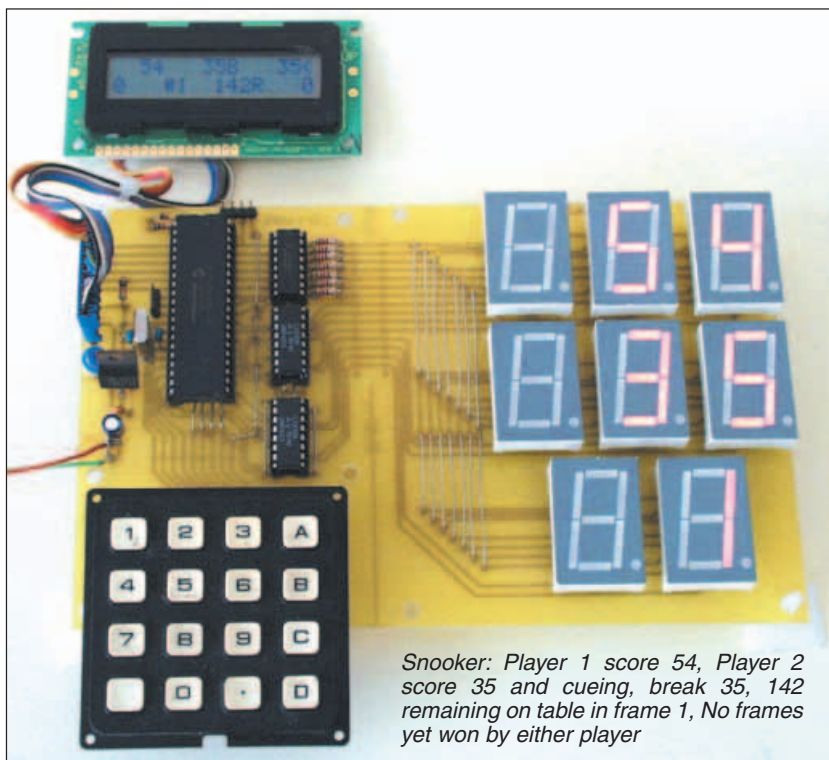
Ports B and D are jointly responsible for controlling the l.e.d. digits. The coded 7-segment data (as discussed in the author's several *PIC Tutorials*) is output from Port B to the voltage level changer and inverting buffer IC3. The buffer's seven output lines are connected via buffer resistors, R3 to R9, to the respective segment cathodes of each l.e.d. The cathodes of each same-lettered segment are commoned (connected together).

Which digit is then turned on is determined by which digit's common anode is powered by drivers IC4 and IC5. Port D controls the digit selection and is synchronised such that the segment code is displayed on the correct digit. The cycle refresh rate is about 100kHz and the eye is oblivious to this rate of cycling (24Hz or 25Hz are the standard frame-change rates used for normal film movies).

Note that only the L293DN (observe the DN suffix) device should be used for IC4 and IC5. There are other L293 devices with different (or no) suffixes, but they have different characteristics and are not suited to this design.

The PIC is run at 4MHz, as set by crystal X9 in association with capacitors C3 and C4.

The PIC can be programmed in situ via connector TB2, whose pins are in the author's standard order. Diode D1 and resistor R1 protect the 5V power line from adverse voltages during programming.



Snooker: Player 1 score 54, Player 2 score 35 and cueing, break 35, 142 remaining on table in frame 1, No frames yet won by either player

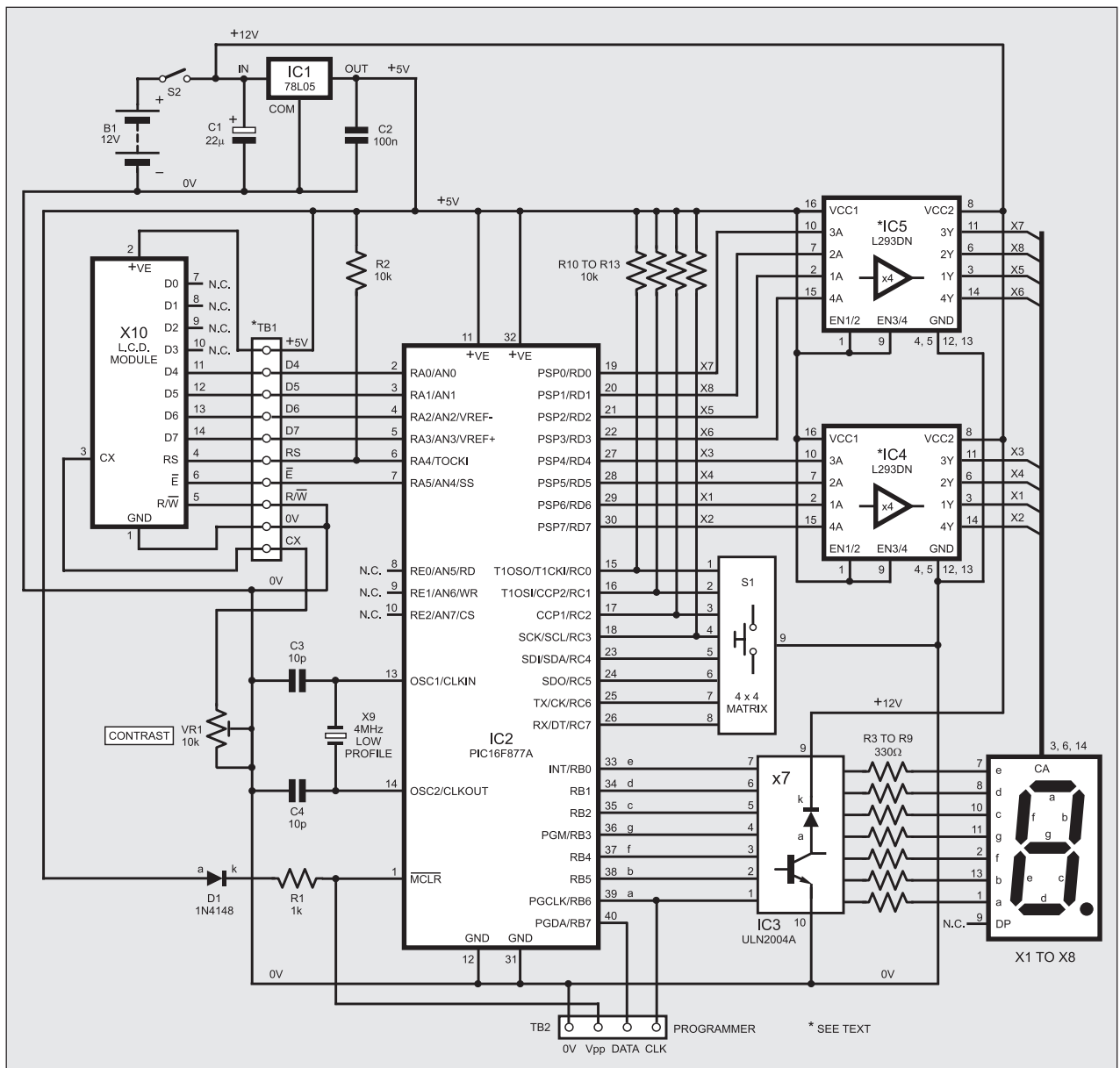


Fig.1. Complete circuit diagram for the Snooker and Darts Scoreboard

## Power Supply

The unit has been designed for powering at 12V d.c. Regulator IC1 reduces this to 5V as required by the PIC, l.c.d. and pins 16 of IC4 and IC5. Pins 8 of IC4 and IC5, and pin 9 of IC3, are powered at the basic 12V input voltage.

The unit may be run at 9V if preferred, although the l.e.d. ballast resistor (R3 to R9) values may need changing in order to increase the segment brilliance – a value of 220Ω each is suggested. A 15V supply could also be used, but the resistor values should then be increased, to say 470Ω.

The current consumption is high, mainly due to that taken by IC4 and IC5 through their 5V connections. Over all, with all l.e.d. digits showing “8”, the total current drawn is about 185mA at 9V, 245mA at 12V, 300mA at 15V. Because the 5V line current is high, it might be preferable that a small heatsink should be used with regulator IC1 (although this was not done with the prototype).

Because of the high current drawn, operation of this unit from a small standard battery is not practical. However, a small 12V rechargeable battery would be ideal. Otherwise, a mains powered adaptor capable of supplying around 500mA at 12V could be used. It is not necessary for the 12V supply to be regulated.

## Construction

Component and track layout details for the unit's printed circuit board are shown in Fig.2. This board is available from the EPE PCB Service, code 530.

The board has been designed so that it may be readily cut into two sections if preferred. In this case the Control section could go in one case on the adjudicator's table, and the Display in another, positioned some distance away for ease of audience viewing.

It will be seen that provision has been made for pin-header connectors to be used at the edges of the two board sections, for

the data signals. A power line connection for this section is not required.

Pinouts for common l.c.d. modules are shown in Fig.3, and those for keypad S1 in Fig.4.

There should be no difficulty over connection cable length, although tests on this have not been made. Whilst the data rate along the cable is moderately fast (100kHz or so), a cable length of two or three metres, or perhaps more, should be satisfactory. The use of colour-coded ribbon cable is recommended.

Provision for linking the keypad to the board via a connector is also made, although with the prototype it was connected directly to the board via a 9-pin single-in-line (s.i.l.) socket.

Assemble the board in order of link wires, quite a few of which are placed under i.c. and l.e.d. socket positions, followed by the sockets. Those for the l.e.d. digits are 7-pin s.i.l. sections, cut from 14-pin d.i.l. sockets and filed smooth.





Fit the remaining components in ascending order of size. Do not insert the d.i.l. i.c.s, i.e.d. displays, or connect the l.c.d. module until a thorough check of the assembly has been made, and the 5V output from regulator IC1 has been proved.

The type of case(s) chosen to house the units(s) is entirely up to personal preference.

## Snooker Program

With all components present, connect power and recheck that powerline voltages are correct, that the l.c.d. module shows two lines of data (adjust preset VR1 to set the best contrast), and that the l.e.d. digits have some values present.

By default, the software runs the Snooker program (darts selection is covered presently). For snooker, the opening l.c.d. display is:



in which all values are in their reset (pre-game) state. Screen line 1 shows, in order, the ">" symbol, indicating that Player 1 is the current active player. Then follow the values of Player 1's score, the current Break count (followed by "B"), and Player 2's score, all zero at present. To the right of Player 2's score a blank cell should be shown.

The bottom line shows the number of frames won by player 1 (0), a "#" symbol and the current frame count number (1), the current value of the balls remaining on the table (147) and followed by "R" (Remaining), and then the frames won by Player 2 (0).

Pressing any of the keys numbered 1 to 7 (ball values) causes that value to be added to the current player's score. Simultaneously, the Remaining value is reduced by the same amount. The exception is when a foul has been called, which does not affect the Remaining count.

Change between players is caused by pressing key "C" (Change Player). If the change is from Player 1 to Player 2, the lefthand ">" on line 1 becomes blank and to the right of Player 2's score is shown "<". Pressing key "C" repeatedly cycles back and forth between players. Each press of "C" also resets the Break count.

Errors in pressing keys 1 to 7 can be corrected by pressing key "A" (Amend), which causes the last value keyed to be deducted from the active player's score, and added back to the Remaining count.

Fouls can be actioned by first pressing the dot key ("."), then pressing the key value appropriate to that to be awarded to the other player, whose score is then updated by that amount. Once that has happened, further presses of 1 to 7 are awarded to the current player as usual. The Remaining count is unaffected for Foul calls.

When the Remaining count has reached zero, the player active at that moment is awarded the frame and their frame score is incremented, and so too is the Frames

Played score. The next frame can then be started by pressing the "Blank" key, which resets the player frame scores to zero, and the Remaining count back to 147.

The l.e.d. digits show the current scores, Player 1 on line 1, Player 2 on line 2. The digits on line 3 show the Frames Played count.

Pressing key "B" (Block), the next l.e.d. digits block displays the current Break count on line 1. Line 2 shows the frames won by Player 1, a hyphen symbol ("-"), and then the frames won by Player 2. Line 3 again shows the current Frames Played count. It is assumed that neither player's frames won score will exceed nine before the game is won (a 19 frame game).

Pressing key "B" again reveals the third l.e.d. digits display block, in which the current Remaining value is shown on line 1. The other digits have no function for this display block and just show hyphen symbols.

The next press of key "B" reveals the first display block again. It is a 3-step repeating cycle.

Keys 0, 8, 9 and D have no function for snooker.

## Darts Program

The Darts program can only be selected when the unit's power is being switched on. With the power off, press key "D" (Darts) and hold it pressed. Switch on the power while keeping "D" pressed. Once the l.c.d. screen has data on it, release "D". The program is now in Darts mode and can only be exited by switching off the power.

On entry to the Darts program, the l.c.d. will show the score for each player from which their throws are to be deducted (the "leg" count starting value). The values are each 501 by default until changed. The lower line shows the message SET HUNDREDS, as below:



The l.e.d. digits show the 501 value on line 1, with lines 2 and 3 showing hyphen symbols (no function).

At this point, the leg count starting value can be changed. In a professional darts game the value is typically 501. In many amateur games, though, 301 might be selected. Other values ending in 01 might also be chosen, depending on the expertise of the players.

For simplicity, the program allows any hundreds value from 101 to 1001 to be selected by pressing the appropriate number key, e.g. "3" for 301. Note that "0" must be pressed for 1001. The selected value is displayed in the Player counts on l.c.d. line 1, and on the l.e.d. digits line 1 (1001 will only show as 001, though).

Once the required value is shown, press "D" (now used as the <ENTER> key). The value is then stored to the PIC's non-volatile EEPROM (electrically erasable programmable read-only memory) where it remains for future recall, even after the power has been switched off. It is the value that will be the default next time the program is run. But it may be changed at that time in the same way as above.

Having pressed "D" the l.c.d. screen shows:



in which both players score values are shown as the selected starting value (501, or other) on line 1. At the centre of line 1 is shown a question mark ("?"). This is where each throw count is temporarily displayed. At either side of Line 2 are shown the current legs won count for each player (0) and the number of the current leg (#1) in the centre.

The l.e.d. digits show 501 (or other) on lines 1 and 2, and the legs count on line 3.

The throw score is entered in standard calculator fashion. Enter the required value using any of the numbered keys (0 to 9) and then press "D" (again being used as the <ENTER> key). The entered value is deducted from the current player's running total.

While the throw score is being entered, the value is progressively shown at the centre of l.c.d. line 1, clearing back to "?" when "D" is pressed.

When a player's total reaches zero, their legs won count is automatically increased by one, as is the total legs count.

If an error is made in keying the correct number, continue by keying in "0" until the screen value reads 000, then key in the correct number. If after "D" is pressed it is realised that the wrong value has been entered, press key "A" (Add) to add the value back to the current player's score.

Although experienced darts players can calculate double and triple scores in their head, for the sake of those who are less able, another option is provided. Key in the basic number scored and press "D", then press the "." key to add the same value to the score again (double score). A second press of "." adds the same value again (triple score).

As with snooker, player change is done by pressing "C" (Change). Similarly l.e.d. display block change is done by pressing "B". There are only two display blocks for darts. The second shows the throw score on line 1 as it is being keyed in. Line 2 shows the legs won scores, and line 3 shows the total legs count (both as with snooker).

Pressing the blank key terminates a leg, incrementing the legs count and resetting player starting scores back to their chosen value (501, or other).

## Software Aspects

There are some aspects of the software code that may be of interest to PIC programming readers. The first is the keypad reading routine. This is set out in full in Listing 1. The comments alongside various command lines should be self-explanatory.

It must be noted that the code is specific to the Port pins hardwired on the p.c.b. In other applications, in which other pin allocations have been made, the code will need to be modified. Examples of other codings can be found in the author's *Using PICs with Keypads* referred to earlier, and his *PIC Controlled Intruder Alarm* (Apr '02).



The routine in Listing 2 shows the coding that controls the l.e.d. 7-segment display digits. It too is believed to be self-explanatory, but it is worth noting how the common anode control has to turn off the digits (**clrf PORTD**) before writing the 7-segment data to them via Port B. Failure to do so results in "ghosting" of the previous digit's value as well as the required value.

In relation to perhaps using the 7-segment control routine in another application, note that the segment codes are specific to common *anode* displays and the PIC pins to which their segment pins are connected. In this application they are in the order which best suited ease of p.c.b. layout.

A further point of interest regarding the l.e.d. display is that two sets of registers have been used for the respective Player Scores and other data storage variables. One set is usually in binary, using one or two registers (MSB and LSB), depending on the size of the value to be stored. The other set is basically in BCD (binary coded decimal) order and typically needing three bytes (MSB, NSB, LSB).

These registers hold the 7-segment code for decimal values, obtained when the binary values are converted to decimal for the l.c.d. display. This arrangement considerably speeds the rate at which the LEDSONA routine is actioned. Without this pre-conversion, the routine would need to include its own calls to the conversion routines prior to updating each digit display – a very time consuming process as LEDSONA is called so frequently.

## Main Loop

Listing 3 shows the main loop which repeatedly updates the l.e.d. digits, reads the keypad and calls the routines which update score and display data as required. Measurements show that the typical cycling rate is about 100kHz.

Calls to the processing routines when keys are pressed momentarily slow down the multiplexed display cycling, but do not have a significant visual impact on the multiplexing. As a precaution, though, a few extra calls to the LEDSONA display routine are set into some longer sub-routines called by keypresses.

In particular, such a call is repeatedly made while the WAITSWITCHA routine is waiting for a key to be released. Similarly, the PAUSIT delay routine, called following WAITSWITCHA's completion, also makes repeated calls to LEDSONA. PAUSIT at this point is used to eliminate keypress release bounce.

## RESOURCES

Software, including source code files, for this design is available on 3.5inch disk from the Editorial office (a small handling charge applies – see the *EPE PCB Service* page) or it can be downloaded *free* from the *EPE* Downloads site, accessible via the home page at [www.epemag.co.uk](http://www.epemag.co.uk). It is held in the PICs folder, under Snooker Scoreboard.

This month's *Shop Talk* provides information about obtaining pre-programmed PICs and component buying advice.

The PIC program source code (ASM) was written using *EPE Toolkit TK3* software (also available via the Downloads

### LISTING 1

```

;***** GET KEYPAD VAL ROUTINE *****

GETKEY:    clrf SWITCHVAL    ; clear monitoring register
            movlw %11110000  ; set outputs RC7 to RC4 high
            movwf PORTC
            nop               ; pause to allow PORTC to stabilise
            movf PORTC,W     ; get PORTC inputs
            andlw 15         ; isolate bits 0 to 3 (RC0 to RC3)
            btfsc STATUS,Z   ; is result NOT zero (are any keys pressed)?
            return          ; no, so return to main prog
            movlw %00010000  ; yes, find key pressed, trying bit 4 high first
            movwf PORTC     ; output initial val for RC7-RC4
            movwf KEYSTORE   ; and store into KEYSTORE
            clrf ROW        ; clear the Row count

GK2:        movf PORTC,W     ; get PORTC inputs
            andlw 15         ; isolate bits 0 to 3
            btfss STATUS,Z   ; is result zero (keys not pressed)?
            goto GK3        ; no
            movlw MATRIX    ; yes, add keypad matrix size (4 for 4x4)
            addwf ROW,F      ; to Row count
            rlf KEYSTORE,F   ; rotate RC7-RC4 value left
            movf KEYSTORE,W ; get it
            andlw %11110000 ; isolate bits 7-4
            movwf PORTC     ; output to PORTC
            btfss STATUS,C   ; has KEYSTORE high bit entered Carry?
            goto GK2        ; no, so repeat search
            return          ; yes, so return to main prog

GK3:        movwf STORE     ; put current KEYSTORE value into STORE
            clrf COL        ; clear column number count

GK4:        bcf STATUS,C    ; clear Carry flag
            rrf STORE,F     ; rotate right STORE val
            btfsc STATUS,C  ; is Carry flag set?
            goto SUMIT      ; yes, so this key pressed, go finish answer
            incf COL,F      ; no, so try again
            goto GK4        ; repeat search

SUMIT:      movf ROW,W      ; sum up results to single answer
            addwf COL,W     ; add ROW to COL (total value between 0 and 15)
            call CONVERTKEY ; convert this val to actual number of key
            movwf SWITCHVAL ; (as given in called table), and store it
            return          ; return to main program

```

### LISTING 2

```

;***** SHOW 7-SEGMENT DIGITS *****

LEDSONA:    movf DIGITNUMBER,W ; get digit count value
            call ITEMNUMBER    ; get address of register to be displayed
            movwf FSR          ; put into indirect access register
            movf INDF,W        ; get segs val from reg pointed to
            clrf PORTD        ; turn off 7-seg anode enable (IC4/5)
            movwf PORTB       ; put segs data out to PORTB
            call DIGSHW       ; get which digit to show it on
            movwf PORTD       ; set PORTD digit select code accordingly
            incf DIGITNUMBER,F ; increment digit select multiplex count
            bcf DIGITNUMBER,3 ; restrict to 0 to 7
            return            ; return to main program

```

### LISTING 3

```

;***** MAIN SNOOKER LOOP *****

MAIN:       call LEDSONA      ; display current l.e.d. digit
            call GETKEY       ; get key pressed if any
            movf SWITCHVAL,W  ; get result value
            btfsc STATUS,Z    ; is it greater than zero (key pressed)?
            goto MAIN        ; no, not pressed, repeat for next digit
            andlw %00001111   ; yes, key pressed
            movwf SWITCHVAL   ; isolate val in bits 0 to 3
            call ROUTESWITCH  ; process routine pointed to by this val
            call WAITSWITCHA  ; wait until key is released
            goto MAIN        ; repeat the loop

```



**Table 1: L.E.D. Array Block Data Display Cycle**

Block	Line	Snooker	Darts
1	1	Player 1 score	Player 1 score
1	2	Player 2 score	Player 2 score
1	3	Frames count	Legs count
2	1	Break count	Current throw
2	2	Frames won scores	Legs won scores
2	3	Frames count	Legs count
3	1	Balls remaining	-
3	2	-	-
3	3	-	-

**Table 2: Keypad Switch Use**

**Snooker**

- 1 to 7 ball numbers
- 0, 8, 9 No action
- A (Amend) subtract last entry
- B (Block) Change LED Display Block
- C (Change) change player
- D No action
- Foul
- ☐ (blank key) increment Frame count

**Darts**

- 0 to 9 score value entry (calculator style)
- A (Add) add back last score value entry
- B (Block) change LED display block
- C (Change) change player
- D (Deduct) (Enter) subtract score from countdown
- Deduct value again (for doubles/triples)
- ☐ (blank key) increment Leg count

**Table 3: Prototype Measurements**

	9V	12V	15v	PIC and regulator only 8mA
All Digits Off	95mA	95mA	95mA	Each L293DN draws approx 40mA
All 8s On	188mA	245mA	300mA	Heatsink recommended for IC1 (see text)

site) and a variant of the TASM dialect. It may be translated to MPASM via *TK3* if preferred. The run-time assembly is supplied as an MPASM HEX file, which has configurations embedded in it (crystal XT, WDT off, POR on, all other values off). If you wish to program the PIC yourself, simply load this HEX file into the PIC using your own PIC programming software and hardware.

Be aware that the code, which has been written for a PIC16F877A, is not compatible with the ordinary PIC16F877 device. However, readers familiar with PIC programming can make it compatible by just two changes. At the head of the ASM listing are the statements

List P = PIC16F877A  
include P16F877A.inc

in which the "A" should be deleted:

List P = PIC16F877  
include P16F877.inc

Assembling the ASM code will now generate a HEX file suitable for the standard PIC16F877 device. ☐



Dun Laoghaire  
College of Further Education  
17 Cumberland Street  
Dun Laoghaire  
Co.Dublin Ireland

email: [info@dlcfe.ie](mailto:info@dlcfe.ie), web: [www.dlcfe.ie](http://www.dlcfe.ie)  
Telephone 01 2809676

**ADVANCED CERTIFICATE**  
in  
**MICROELECTRONICS & COMPUTING**

2 year full time course  
Links to Degree Courses  
through  
Higher Links Scheme

[www.dlcfe.ie](http://www.dlcfe.ie)

Subjects include the following

- Analogue Electronics
- Digital Electronics
- Microcontroller Systems ( Atmel )
- Computer Maintenance
- Networking
- Computer Programming

**Please  
mention EPE  
when replying to  
advertisements**

---

**To advertise your  
company  
Contact:  
Stewart Kearn  
Tel: 01202 873872  
Email:  
[stewart.kearn@wimborne.co.uk](mailto:stewart.kearn@wimborne.co.uk)**



**www.SPystoreUK.com**

**Professional Surveillance & Security Equipment**

**Day & Night Camera**



**Only £69.00**

**High Power Video TX**



**Only £35.00**

**Mini Video RX**



**Only £69.00**

**UHF Audio TX**



**Only £190.00**

**GSM Alarm**



**Only £199.00**

**Bitz Technology Ltd**

**Tel: +44 (0) 208 968 0227**

**[www.spystoreuk.com](http://www.spystoreuk.com)**

All Prices exclude P&P and VAT.

# PRACTICALLY SPEAKING

**Robert Penfold looks at the Techniques of Actually Doing It!**

**A**T school we learned about metres and kilograms, or for those of my generation and older it was feet, inches, pounds and ounces that we learned to use. The units of measurement used in electronics are less widely taught. Consequently, many people making a start in the hobby of electronics construction would not have learned about Ohms, Farads, and Henries at school.

Matters are complicated by the fact that some of the basic units of measurement used in electronics are either very small or huge. One minute you might be soldering a 5,600,000 ohm resistor to a circuit board, and the next you could be fitting a 0.000000001 farad capacitor!

The range of values covered is immense for some components. With resistors, for instance, the highest value that is generally available is a hundred million times larger than the lowest available value. The equivalent figure for capacitors is over one thousand million!

## High Capacity

This can all be a bit confusing at first, but it all becomes very straightforward if things are rationalised.

Taking capacitors first, the basic unit of measurement is the farad, but for normal electronic circuits this is a huge amount of capacitance. The highest value I have ever used is a mere 0.0047 farads.

High value capacitors normally have their values expressed as so many microfarads, and one microfarad is equal to a millionth of a farad. The 0.0047 farad capacitor mentioned previously would normally have its value given as 4700 microfarads.

Even a microfarad is a substantial amount of capacitance by normal electronic standards. Many capacitors have values given in nanofarads

or picofarads. A nanofarad is one thousandth of a microfarad, and a picofarad is one thousandth of a nanofarad or one millionth of a microfarad in other words.

## Abbreviation

The micro, nano, and pico prefixes are not specific to capacitance. They are used generally in metric measurement to indicate one millionth, a thousand-millionth, and a million-millionth of something.

The abbreviation for micro is the Greek letter mu ( $\mu$ ), but a lower case letter "u" is often used instead. On a circuit diagram or in a components list a 47 microfarad capacitor would therefore have its value given in the form "47 $\mu$ F" or "47uF". Presumably working on the basis that the farad is always the basic unit of measurement for a capacitor, this value would often be given as just "47 $\mu$ " or "47u".

The respective abbreviations for nanofarads and picofarads are "n" and "p", and these letters should always be in lower case. A value of 680 picofarads would therefore appear as "680pF" or just "680p" on a circuit diagram. A value of 22 nanofarads would be marked as "22nF" or "22n".

Space on circuit diagrams tends to be strictly limited, so things are often taken a stage further with the unit of measurement indicating the position of the decimal point. For example, values of 2.7 picofarads and 4.7 nanofarads are often given as "2p7" and "4n7" respectively.

## On Your Marks

The value markings on capacitors can be something less than obvious at first glance. A 330 picofarad capacitor could and in many cases would have its value shown as "330p". Particularly

with ceramic capacitors, it is quite likely to be marked as "n33". In other words, the value is 0.33 nanofarads, which is actually the same as 330 picofarads.

Capacitors having values from 100 nanofarads to 820 nanofarads have a similar problem. A "470n" component might be specified in a components list, but this value could be given as 0.47 microfarads in some component catalogues.

This is most likely to occur with electrolytic components, which often have all the values given in microfarads in component catalogues.

---

*"A nanofarad (nF) is one thousandth of a microfarad"*

---

## Letter Imperfect

Capacitors often have other markings, such as the maximum voltage rating and their tolerance. The latter is simply the maximum amount that the actual value of the component can differ from its marked value.

With capacitors the tolerance is often indicated by a single letter and a simple method of coding, so be careful not to interpret a tolerance code letter as part of the value. These are the tolerance ratings for the common code letters:

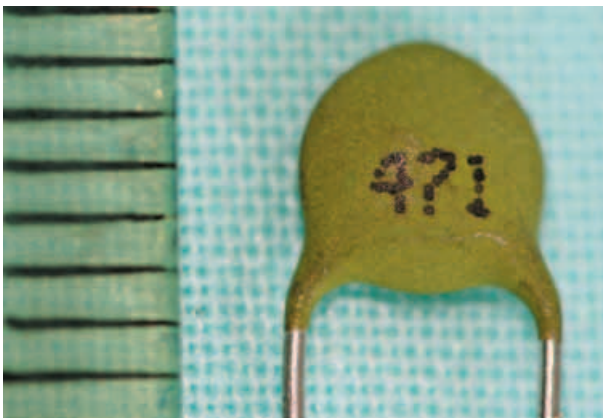
Code Letter	Tolerance
F	+/- 1%
G	+/- 2%
H	+/- 3%
J	+/- 5%
K	+/- 10%
M	+/- 20%

Capacitor value markings are sometimes in the form of a three-digit number. The first two digits of the label are simply the first two digits of the value. The third digit is the number of zeros that have to be added to the basic two-digit value.

For example, a capacitor marked "223" has "22" as the first two digits of the value, and three zeros must be added to these in order to provide the full value. This gives an answer of 22000, and as the value is in picofarads this is what would normally be regarded as a 22 nanofarad capacitor.

The example shown in Fig.1 is marked "471", indicating that it has a value of 470 picofarads. It is pictured beside the one-millimetre markings of a ruler, and the lettering is only a little over one-millimetre high. There are plenty of modern capacitors that are far smaller than this example, so even those with good eyesight might find it necessary to use a magnifier of some kind.

At one time it was common for some types of capacitor to have their value, voltage, and tolerance ratings marked using a system of colour coding. This method was based on the system of coding used for resistors, and had its advantages. However, it fell from favour some years ago and does not seem to be in use any more.



*The three digit marking of 471 on this miniature capacitor (pictured beside the one-millimetre markings of a ruler) indicate it has a value of 470pF – 47 plus one zero*

## Resistance

The basic measurement of resistance is the Ohm. Normal resistors are generally available with values from about 1 ohm to 10 million ohms. High-power resistors are only available with relatively low values, going down to about 0.1 ohms.

The Greek letter omega ( $\Omega$ ) is used to indicate that a value is in ohms, so a 330 $\Omega$  resistor has a value of 330 ohms. There can be practical difficulties in using anything other than normal alphanumeric characters, so the letter "R" is often used in place of omega. A value of 330 ohms would therefore appear on a circuit diagram or in a components list as either "330 $\Omega$ " or "330R", or perhaps even as just "330". (EPE always uses the omega symbol.)

---

---

***"A picofarad (pF) is one thousandth of a nanofarad or one millionth of a microfarad ( $\mu$ F)"***

---

---

As with capacitance, it is now standard practice for the character denoting the unit of measurement to also indicate the position of the decimal point. A 5.6 ohm resistor would therefore have its value given in the form "5 $\Omega$ 6" or "5R6".

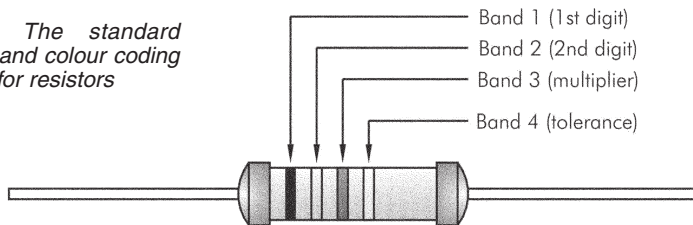
The basic ohm is used when dealing with resistors of several hundred ohms or less, but kilohms and megohms are used for higher value components. The prefixes "kilo" and "mega" are used in the metric system to respectively denote one thousand and one million of something. A kilometre is a thousand metres, and a kilohm is a thousand ohms.

The abbreviation for kilohm is "k $\Omega$ " or just "k", and the abbreviation for megohm is "M $\Omega$ " or just "M". Again, the letter indicating the unit of measurement is often used to show the position of the decimal point. A value of 4.7 kilohms would normally be marked on a circuit diagram as "4k7", and a value of 3.9 megohms would be marked as "3M9".



*Using a magnifier can also be useful in identifying really small capacitor markings*

*Fig.2. The standard four-band colour coding used for resistors*



## Colour Code

While there are some resistors that have the value written on the body, together with a tolerance rating or code letter, this method is mainly restricted to high power resistors. Resistors having a power rating of about one watt or less almost invariably use colour coding to indicate the value and tolerance rating. The standard four-band coding uses the system shown in Fig.2. Table 1 shows the meaning of each colour, but some colours are only used in certain bands.

At one time it was normal for band 4 to be well separated from the others, but these days there is more or less equal spacing of the bands. There should still be no risk of getting bands 1 and 4 confused and reading the colours backwards. Band 1 is much nearer to its end of the body, and in some cases is right at one end of the body.

As an example of a colour code, suppose a resistor has bands that are green, blue, orange, and gold. Bands 1 and 2 provide the first two digits of the value, which in this case are green (5) and blue (6). The first two digits of the value are therefore "56". The third band provides the multiplier, and in this example it is orange ( $\times 1000$ ). This gives a final value of 56  $\times 1000$ , which is 56000 ohms or 56k $\Omega$ . The fourth band is gold, indicating that the resistor's value has a tolerance of plus and minus 5%. It is worth bearing in mind that it is perfectly acceptable to use a component that has a tighter tolerance than the one specified in the components list. For instance, a 1% component can be used instead of a 5% type, but a 5% component should not be used in place of a 1% type.

Some resistors have a fifth band, but this only indicates the temperature coefficient of the component, which is normally of no great consequence. Therefore, you can just ignore the fifth band and use the first four in the normal way.

There is another five band version of the resistor colour code that seems to pop up every now and then. It uses three bands to provide the first three digits of the value. The other two bands then provide the multiplier and tolerance rating in the usual way.

The point of having three rather than two initial digits is that it enables non-standard values to be accommodated, which is probably of no practical importance to project builders. With normal (preferred) values the third band is always black (0). The value can therefore be calculated by ignoring the third band, and using the other four bands in the normal way. This figure is then multiplied by ten in order to give the actual value. For

**Table 1: Resistor Colour Code**

Colour	Band 1/2	Band 3	Band 4
Black	0	$\times 1$	-
Brown	1	$\times 10$	1%
Red	2	$\times 100$	2%
Orange	3	$\times 1000$	-
Yellow	4	$\times 10000$	-
Green	5	$\times 100000$	0.5%
Blue	6	$\times 1000000$	0.25%
Violet	7	-	0.1%
Grey	8	-	-
White	9	-	-
Gold	-	0.1	5%
Silver	-	0.01	10%
None	-	-	20%

instance, if the four bands give an answer of 22k, the resistor is actually a 220k component. Ending up with a mixture of normal four-band resistors and components that use this five-band method of coding would be likely to produce confusion and errors. If possible, avoid resistors that use this form of five-band coding.

---

---

***"The abbreviation for ohm is  $\Omega$ , for kilohm is k $\Omega$  and for megohm is M $\Omega$ "***

---

---

## Choked Up

Inductors, which are also called chokes, are not used a great deal in electronic projects. The basic unit of inductance is the Henry, which is a very large amount of inductance. Most inductors have their value given in microhenries, which are millionths of a henry. Large inductors have the value specified in millihenries (thousandths of a henry).

Large inductors mostly have the value written on the component, possibly with other parameters included such as a maximum operating current. Physically small inductors for use in low power applications often have the value marked using colour coding. The system used is essentially the same as the standard four-band resistor colour code, but it gives a value in nanohenries. Divide by one thousand to obtain a value in microhenries, or by one million for an answer in millihenries.

For example, suppose an inductor has the colour code yellow, violet, red, and gold. The first three colours provide a figure of 4700 ( $47 \times 100$ ), and dividing this by one thousand gives a value of 4.7 microhenries. The gold band indicates that the tolerance rating of the component is plus and minus five percent.



# Controlling Model Railway Signals

John Waller

## Using stepper motors to control the semaphore signals used with model railways

**I**N modern railways semaphore signals have mostly given way to coloured-light signals, or no signals at all, at least those at the side of the track. But in the model railway world there is a desire to include semaphore signals since part of the attraction of the hobby is the ability to show the way things were.

This article follows on from that by the late Andy Flind, *PIC Quickstep* (June '04), which gave a very good introduction to stepper motors and the means of testing them. Here a specific application for stepper motors is described, using them to control the movement of semaphore signal arms.

A number of matters are covered which will need to be considered for any stepper motor application. Even if a reader is not interested in model railway signals, the solutions adopted herein may be a useful guide.

### Signal Positions

The signal being controlled here is of the upper quadrant type, and is set to one of three positions to assert train control:

- The semaphore is set horizontally, and shows a red light, to signify danger; trains *must* stop in front of the signal
- The semaphore is set to 45° up, and shows a yellow light, to signify caution or "approach"; trains may proceed past the signal, but not exceeding a designated speed
- The semaphore points upright, and shows a green light, for safe or "clear"; train speed is unlimited by the signal alone. There are, of course, always other limitations on train speed

The semaphore signal is thus a good candidate for stepper motor control.



Photo 1. The stepper motor used in this controller

### Stepper Motor

The 4-phase unipolar stepper motor used here is shown in Photo 1. The overall case is about 30mm in diameter. It is supplied by 12 volts and each of the four coils has a resistance of 200Ω. The output shaft is offset from the centre of the housing, indicating there is a gearbox inside. The shaft itself is rectangular, 5mm by 3mm, with rounded corners. This makes it simple to attach something to the shaft.

The motor comes with wires already connected to a 5-pin female header, with red as the common lead.

### Semaphore Signal

Photo 2 shows the signal before connection to the motor. It is made by Tomar Industries, type H-853 (HO scale). The quadrant contains coloured lenses to show

*Photo 2. The H-853 semaphore signal, courtesy of Tomar Industries ([www.tomarindustries.com](http://www.tomarindustries.com))*

red, yellow, and green for the stop, caution, and safe positions, respectively, by being aligned to a white lamp. Thus it is important to position the quadrant to bring the appropriate lens in front of the lamp assembly.

The lamp assembly itself contains an incandescent bulb supplied by 1.4 volts.

The mast contains the two wires for the lamp, and a piano wire. Pulling the wire down raises the semaphore (and pushing it up lowers the semaphore). The attribute of an upper-quadrant signal in real life is that it will fall to the danger position if the driving mechanism fails. There is mostly too much friction in a model to do this.

### Connecting the Signal

Photo 3 shows details of the mechanical connection between the signal and the

motor. A plastic piece 30mm by 8mm, and 2mm thick is cut to fit over the shaft and glued into place. The semaphore wire is bent at 90° and inserted through a hole in the plastic and bent again to keep it in place.

The hole is 6mm from the shaft centre. The motor is mounted by means of slots and is positioned, with the semaphore at caution, to make the plastic piece approximately horizontal. Also shown are two mechanical stops, about which more will be said presently. Looking at the shaft end, the motor turns anticlockwise to raise the semaphore arm.

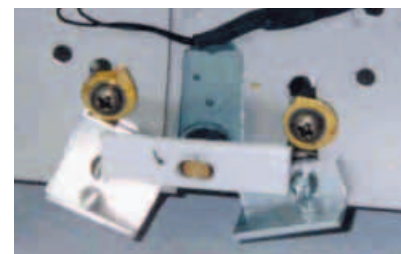


Photo 3. Connecting the signal to the motor

### Motor Controller

The controller closely follows the concepts described by Andy Flind. A PIC16F628 is used with internal 4MHz clock, and all available pins, 16 in number, configured for digital I/O (input/output), noting that RA5 can only be an input. The circuit diagram for the Model Railway Signal Controller is shown in Fig.1.

The employment of 16 pins allows two complete motors to be driven, via transistors TR1 to TR8 which are buffered by resistors R3 to R10. There are also two outputs (RA6, RA7) for the lamps fitted to each signal, which allow the lamps to be flashed to warn trains that automatic block and signal control has failed, and trains must proceed slowly as if in an uncontrolled yard.

The values for resistors R13 and R14 should be chosen to suit the current drawn by the signal lamps. A value of 390Ω was needed with the prototype.

The transistors may be any small *npn* type capable of driving motors and lamps, such as

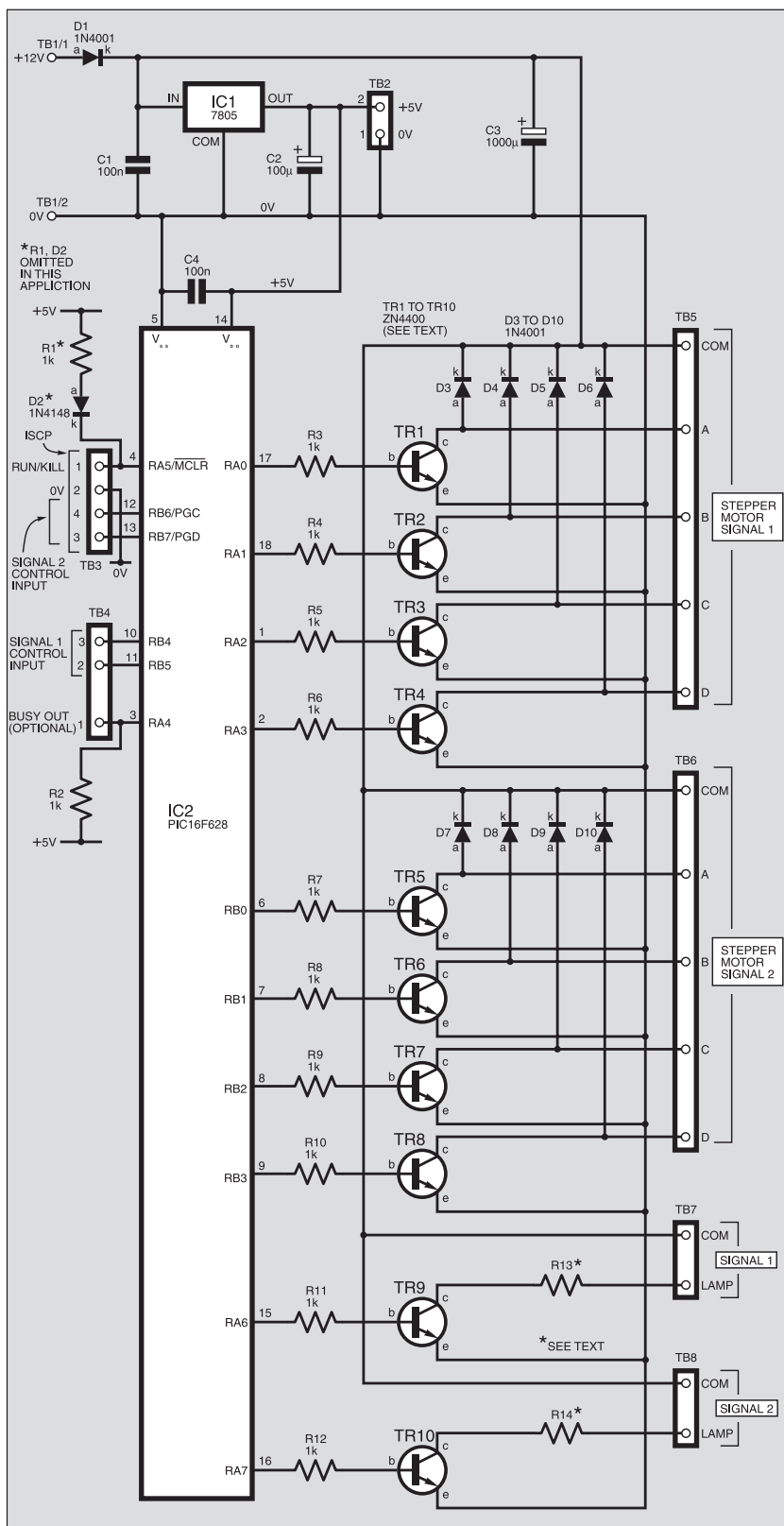


Fig.2. Circuit diagram for the Model Railway Signal Controller

ZN4400 or ZTX653 and having the same pin order as required by the printed circuit board. Diodes D3 to D10 suppress back e.m.f. pulses generated by the motor coils.

### Controller I/O Allocation

The PIC's input/output allocation is itemised in Table 1, and the position orders from the host system are shown in Table 2.

The RUN/KILL input from the host system is used as follows:

- RUN, with RA5 set, indicates the host system is operating normally, and semaphore position orders should be obeyed
- KILL, with RA5 cleared, indicates an abnormal condition. Semaphore position orders are ignored and both signals are set to

## COMPONENTS

### Resistors

- R1 to R12 1k (12 off)  
R13, R14 to suit signal lamps 0.5W (see text) (2 off)  
R15 to R23 1k (9 off) (test only, see text)

All 0.25W 5% carbon film

### Capacitors

- C1, C4 100n ceramic disc, 5mm pitch (2 off)  
C2 100μ radial elect. 25V  
C3 1000μ radial elect. 25V  
C5 1μ radial elect. 25V (test only, see text)

### Semiconductors

- D1, D3 to D10 1N4001 rectifier diode (9 off)  
D2 1N4148 signal diode  
D11 to D14 red l.e.d. (4 off) (test only, see text)  
TR1 to TR10 ZN4400 or ZTX653 npn transistor (10 off)  
IC1 78L05 +5V 100mA voltage regulator  
IC2 PIC16F628 microcontroller, pre-programmed (see text)

### Miscellaneous

- TB1 to TB8 1mm terminal pins or pin header blocks  
S1 to S5 s.p.s.t. min. toggle switch (5 off) (test only, see text)

Printed circuit board available from the EPE PCB Service, code 529; semaphore signal, Tomar Industries, type H-853 (HO scale) or to suit; stepper motor; 18-pin d.i.l. socket; connecting wire; solder, etc.

Approx. Cost  
Guidance Only

**£16**

excl signal & case

Table 1: PIC Input/Output Allocation

Pin	Direction	Function
RA0	O	motor 1 pole A
RA1	O	motor 1 pole B
RA2	O	motor 1 pole C
RA3	O	motor 1 pole D
RA4	O	Busy to host
RA5	I	RUN/KILL from host
RA6	O	Semaphore 1 lamp
RA7	O	Semaphore 2 lamp
RB0	O	motor 2 pole A
RB1	O	motor 2 pole B
RB2	O	motor 2 pole C
RB3	O	motor 2 pole D
RB4	I	position 1 order from host
RB5	I	position 1 order from host
RB6	I	position 2 order from host
RB7	I	position 2 order from host

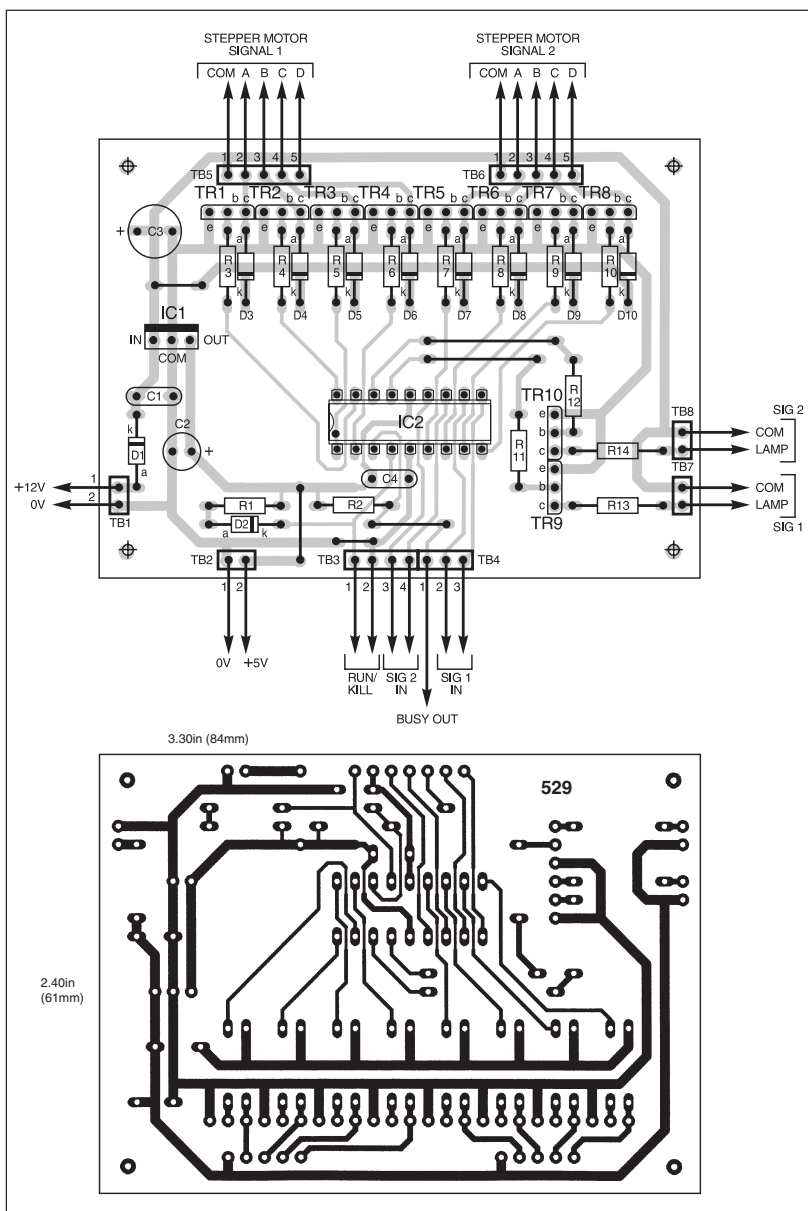


Fig.2. Component and track layout details for the Model Railway Signal Controller printed circuit board

clear with the lamps flashing. This message also goes to the train digital command control (DCC), which removes the control and power signal from the train tracks; see the author's article *Digital Command Control for Model Trains* (Aug '03). All trains stop (no doubt real railways would relish having this capability!).

## Construction

Component and track layout details for the Model Railway Signal Controller printed circuit board are shown in Fig.2. This board is available from the *EPE PCB Service*, code 529.

Assemble the board in the usual order of ascending component size, taking care to position the diodes, transistors and electrolytic capacitors correctly as shown. Use a socket for the PIC, but do not insert the PIC until the board has been double-checked for correct component positioning, and that the output from regulator IC1 is at 5V, within a few millivolts.

Minimum and maximum motor rotation end stops can be fitted alongside the motor,

using small angled plates bolted to the backing plate. Software is set to cut out the motor at the correct points, but the end stops prevent undue force being applied to the signal lever.

## Initialising the Signal

The host system starts up with RUN cleared. The signal moves to the clear position, and the lamp flashes. The number of motor steps assigned to this operation is sufficient that the signal will reach the clear position no matter where it starts from. All or part of this operation will be with the stepper motor driving against the stop (see Photo 3).

No damage occurs here, and the condition only lasts for about a second. But it guarantees putting the signal into a known position regardless of where it has been left with the power off. It is easy to turn the motor by hand, for example.

## Backlash

Any mechanical system has some degree of backlash, or "lost motion". Most of the backlash with the signal is at the ends of the

Table 2: Position Orders from Host System

Order	RB4 and RB6	RB5 and RB7
No action	0	0
Danger	1	0
Caution	1	1
Safe	0	1

piano wire, with some in the motor gearbox. The user will have some control here according to the size of the hole in the arm attached to the motor shaft (Photo 3). Making the hole larger increases the backlash, decreasing it increases the friction.

The stiff piano wire should also be bent very carefully. The mechanical stop at the clear position is set so the signal semaphore arm is upright. The calibration procedure (see later) allows the number of steps, from any position to any other position, to be adjusted. These measures help to overcome the effects of backlash.

## Software

The author used John Becker's simulation facility that has been part of his *TK3* PIC programmer since V3.00. It was discussed in the March '05 issue, *PIC Toolkit TK3 Simulator and PIC18F Upgrade*.

Such a simulation is particularly useful for a PIC16F628 where all I/O (input/output) pins are allocated, with none to spare, for example to drive an alphanumeric liquid crystal display module, which can be very useful for debugging.

The high-level flowchart of the signal control program is shown in Fig.3. A timing loop circulates continuously, initiating action every eight milliseconds. At each such interval, the stepper motors are turned off, whether either are on or not from the previous interval. If required, a different pole piece in a motor is then energized. The operations which take place may be summarised as follows:

**Prototype p.c.b. mounted on enclosure holding the stepper motor internally, and signal on top. The p.c.b. differs slightly from the published version**





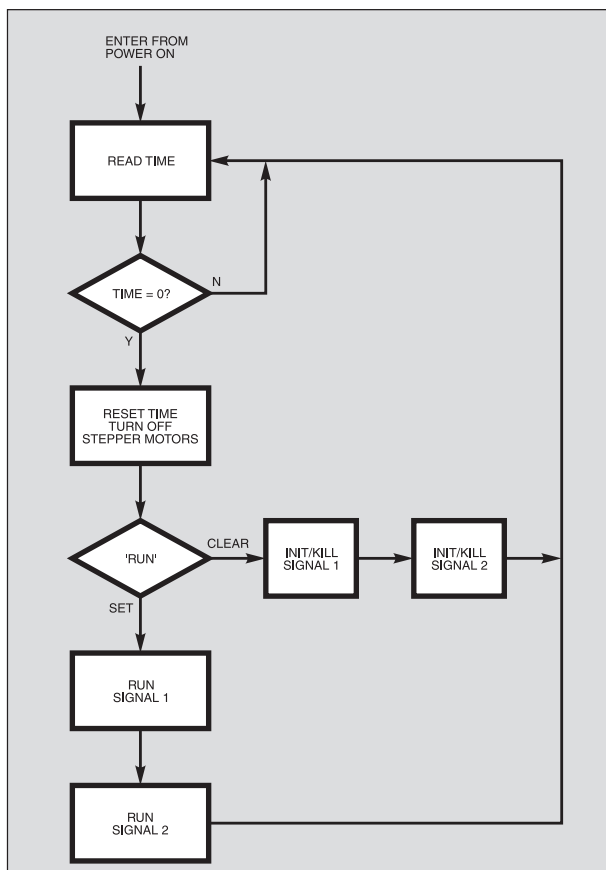


Fig.3. High-level flowchart of the signal control program

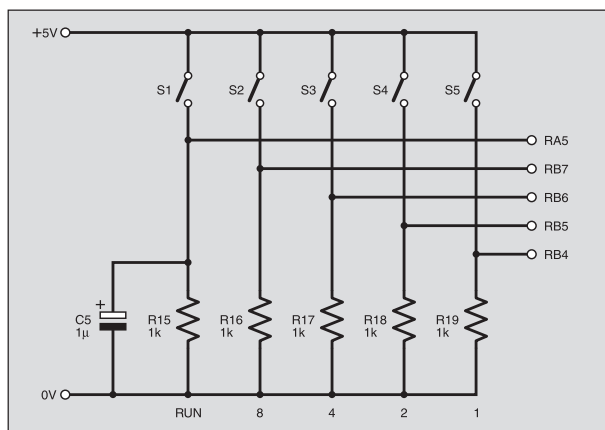
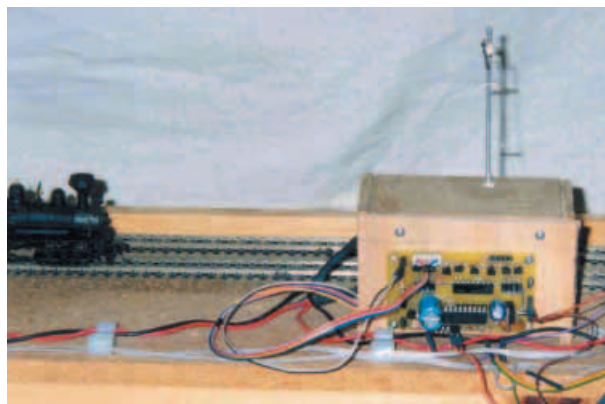


Fig.4. Calibration circuit diagram

- With RUN cleared, the semaphores are driven to the clear position (upright) and the signal lamp is toggled, as already explained, to indicate the host system is waiting to run, or has lost control over automatic operations. Once the motors have moved the number of steps designated for red to green motion, no further motor action occurs. If RUN is set before this occurs, the operation will always be completed first.

- With RUN set, the signal lamps are always on and the controller awaits a new order from the host system, always completing an existing order before starting a new one.

In practice, even in a model railway environment, the motors spend most of their time idle. The time interval of eight milliseconds is adjustable by factors of two, by changing the value of a mask in the software. The software is contained in the file **stepmtr.asm** (available as stated later).

The issue of completing an existing operation before commencing a new one could be contentious, especially if the new operation is to set a signal to danger. There is no queue of pending operations; the one that is present when the current operation is completed is the one executed next. The author will review this aspect after gaining experience with the controller. Interruption of an existing operation would be possible.

## Testing

The stepper motor controller is tested and calibrated with a test box whose circuit diagram is shown in Fig.4. Constructional details for this are not offered, and it may be readily assembled on stripboard.

The test box simulates the commands from the host system, as shown in Table 1. The power for the box comes from the 5V/0V pins allocated on the p.c.b.

In Fig.4, switch S1 controls the RUN/KILL command, and the other four simulate the commands given in Table 2. The test box provides all of the functionality pertaining to normal operations; the switches and other components are mounted in a utility box.

Again following Andy Flind, a useful test device is shown in Fig.5 for monitoring outputs to a motor. It is inserted in the five-way cable between the controller and the motor, using compatible male and female headers. The i.e.d.s flash as the motor steps.

## Calibration

Because of the mechanical tolerances in the system, especially backlash, the test box also provides means of calibrating each movement of the signal, as a number of steps stored in the PIC's EEPROM. The user would start with nominal values as given in the file **stpmtr.msg**, which is loaded separately into the PIC, using TK3's facility for this, or that of other programmers.

At each step of the calibration, the user selects the movement to be tested by setting the switches as given in Table 3. The switch settings column is the result of treating the switch positions as a binary sequence, as shown in the first four columns. Switch settings of 12 or greater are ignored.

To run the calibration the motor controller is powered on with the RUN switch (S1) closed, and then opened after the signal lamp lights. Normal operations with the host system are powered on with RUN cleared. The

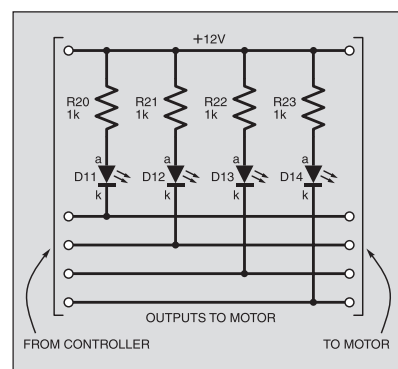


Fig.5. Motor test display circuit

calibration software has a timing loop similar to the main timing loop, but which runs much more slowly. The procedure is as follows:

- Make sure the semaphore has already been set to the required start position. For example, if the steps green to red or yellow are being calibrated, it is best to power on with RUN cleared, whereby the semaphore is set hard against the stop in the upright position, as already explained, then reset the controller with power off, set RUN, then power on again, to get back to calibrate. In other instances, the semaphore might already be in the yellow or red position from a previous calibration operation.

- Set the test box switches for the desired movement and signal from Table 3.

- Close the RUN switch and observe the movement of the semaphore.

- When the semaphore is in the required position, open the RUN switch; this stops

the movement and the number of steps for that movement is loaded automatically into the PIC's EEPROM, where it stays even after the power has been removed.

The procedure may be repeated as often as needed. The additional mechanical stop shown in Photo 3 should be used to prevent the motor moving the semaphore too far below the horizontal; the stress of a stalled motor is better taken by the stop and not the signal mechanism.

As a matter of perception, it looks bad if the arm is not truly upright or truly horizontal, for clear and danger positions, respectively. Conversely, the average observer will not notice if the arm is not exactly at 45° in the caution position, provided the yellow lens is aligned to the lamp, and there is some tolerance in this.

The calibration procedure provides means for setting the number of steps to reach the clear position. The author prefers to set default values here which ensure the semaphore will initialise to green from anywhere, as already explained. But the user can choose otherwise, and may also adjust step numbers in the **stpmtr.msg** file and load it into EEPROM (see Table 4). If **TK3** is used for this, it is possible to read the PIC's EEPROM contents after a calibration session.

## Resources

Software, including source code files, for the Signals Controller is available on 3.5inch disk from the Editorial office (a small handling charge applies – see the *EPE PCB Service* page) or it can be downloaded *free* from the *EPE* Downloads site, accessible via the home page at [www.epemag.co.uk](http://www.epemag.co.uk). It is held in the PICs folder, under Train Signals. Download all the files within that folder.

This month's *Shoptalk* provides information about obtaining pre-programmed PICs.

If programming the PIC in situ, normal operating connections are removed from TB3/4 in order to connect the programming leads.

The PIC program source code was written using *EPE Toolkit TK3* software (also

**Table 3: Selecting Calibration Movement**

RB7	RB6	RB5	RB4	Switch settings	Semaphore	Movement
S2	S3	S4	S5			
0	0	0	0	0	1	green to red
0	0	0	1	1	2	green to red
0	0	1	0	2	1	green to yellow
0	0	1	1	3	2	green to yellow
0	1	0	0	4	1	red to green
0	1	0	1	5	2	red to green
0	1	1	0	6	1	red to yellow
0	1	1	1	7	2	red to yellow
1	0	0	0	8	1	yellow to green
1	0	0	1	9	2	yellow to green
1	0	1	0	10	1	yellow to red
1	0	1	1	11	2	yellow to red

**Table 4: Number of steps values for upper quadrant signals H-853**

1	; High count (A) green to red
20	; Low count (A) green to red
1	; High count (B) green to red
20	; Low count (B) green to red
0	; High count (A) green to yellow
138	; Low count (A) green to yellow
0	; High count (B) green to yellow
138	; Low count (B) green to yellow
1	; High count (A) red to green
20	; Low count (A) red to green
1	; High count (B) red to green
20	; Low count (B) red to green
0	; High count (A) red to yellow
138	; Low count (A) red to yellow
0	; High count (B) red to yellow
138	; Low count (B) red to yellow
0	; High count (A) yellow to green
138	; Low count (A) yellow to green
0	; High count (B) yellow to green
138	; Low count (B) yellow to green
0	; High count (A) yellow to red
138	; Low count (A) yellow to red
0	; High count (B) yellow to red
138	; Low count (B) yellow to red

available via the Downloads site) and a variant of the TASM dialect. It may be translated to MPASM via **TK3** if preferred. The run-time assembly is supplied as an MPASM HEX file, which has

PIC16F configurations embedded in it. If you wish to program the PIC yourself, simply load this HEX file into the PIC using your own PIC programming software and hardware. ☐

## Obtaining EPE

An initiative in the UK is designed to help you obtain your favourite magazines from newsagents. Called *Just Ask!* its aim is to raise awareness that newsagents can stock, order and often home deliver magazines.

To raise awareness we will be including the Just Ask! logo in the pages of this and future issues and have included a newsagent order form to help you to obtain copies.

So keep a look out for the logo and next time you visit your newsagent remember to Just Ask! about obtaining copies of your chosen magazines.



## NEWSAGENTS ORDER FORM

Please reserve/deliver a copy of *Everyday Practical Electronics* for me each month

Signed .....

Name and Address .....

.....

..... Post Code ..... Tel .....

*Everyday Practical Electronics* is published on the second Thursday of each month and distributed S.O.R. by COMAG  
Make sure of your copy of *EPE* each month – cut out or photostat this form, fill it in and hand it to your newsagent.

# READOUT

Email: [john.becker@wimborne.co.uk](mailto:john.becker@wimborne.co.uk)

**John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!**

## WIN AN ATLAS LCR ANALYSER WORTH £69

An Atlas LCR Passive Component Analyser, kindly donated by Peak Electronic Design Ltd., will be awarded to the author of the *Letter Of The Month* each month.

The Atlas LCR automatically measures inductance from  $1\mu\text{H}$  to  $10\text{H}$ , capacitance from  $1\text{pF}$  to  $10,000\mu\text{F}$  and resistance from  $1\Omega$  to  $2\text{M}\Omega$  with a basic accuracy of 1%.



## ★ LETTER OF THE MONTH ★

### Digital Terrestrial TV

Dear EPE,

Thank you for Barry Fox's article *Digital TV Switchover* in the June issue. This subject has been a bee in my bonnet for a considerable time.

Barry says: "...A survey...of 4,000 viewers found that more than 70% are angry about [analogue] switch-off and suspicious of the Government's motives." I can't speak for the 2,800 in the survey, but I'll nail my banner to the same flag pole and tell things as they appear to me.

"Why did colour TV come in so quickly and so well?" I'll tell you why. It was because nobody was forced to give up B&W if they didn't want to. A B&W TV still works today, because the colour signal remains compatible with the original B&W standard. That is how it was designed. It would be far more relevant to compare digital switch-over with the change from 405 to 625 lines, which meant a period of simultaneous transmission on VHF and UHF until the population of active VHF receivers diminished below what was reasonable.

### Out of Line?

The change from 405 to 625 lines, and then the introduction of colour, both conveyed significant improvements to the service that rewarded the audience with a much better viewing experience. Can the same honestly be said for digital terrestrial TV? As far as I can see, the consequences of having more channels to fill are that the existing resources are diluted across them. Witness the BBC having to trim its production teams, basically to find the funds to buy in more rubbish to populate the schedules. Witness also the migration of the traditional quality viewing away from the old traditional (analogue!) channels.

It seems to me that nobody has made a rational case for why we want digital terrestrial at all. Anyone who really wants lots of channels to surf can do so already, because they will have been drawn to satellite or cable before now. What other case (for the consumer) can there be? Improved picture quality? Maybe, but does anybody seriously have anything to complain about with 625-line PAL colour? Does anyone really need DVD picture quality on a broadcast channel?

### Gainers and Losers

Having established in my thesis that the consumer has no need of it, and that the content will be worse as a result of it, who is driving it forward?

The broadcasting industry and Government, that's who. Why are they so keen? Money. The Government sees the possibility of licensing a whole new raft of services, and releasing the old frequencies for even more.

The broadcasters see new advertising or subscription revenue streams from new channels. Also (and get this one), once the analogue broadcasts are gone there is no guarantee that Freeview will remain free! Encrypted subscription-only TV becomes a distinct possibility. It doesn't matter whether the money comes from direct subscription, frequency licensing, or adverts – the result is the same in the end: we (the consumers) pay.

I don't think the average man in the street has woken up to the full consequences of analogue turn-off yet. He is still being seduced by the idea of lots more TV, but is gradually finding that most of it is utter pap. And, let's face it, you can only watch one channel at a time. He has yet to realise that *every* TV and video recorder throughout the house will have to be replaced, or at least converted with a set-top box. Just one box for the whole house will not do, because that would mean the kids upstairs have to watch the same thing as everyone else.

VCRs are not amenable to set-top boxes either, because there is no way to persuade the box to change channel and record something else unattended. These functions will have to be part of a VCR specifically designed for digital terrestrial. What is the cost of replacing all the receivers in a household? £1500? Hands up caravan owners with a TV, or people who use pocket TVs out and about at sports venues or whatever. You'll have no joy there when analogue is pulled.

### No-Go Nooks

There are nooks and crannies in Britain that manage on a mediocre signal now, but will be no-go for digital. An analogue signal degrades gracefully, and has to go down a long way before it becomes totally indecipherable. Not so with digital: lose enough bits that the error correction gives up, and that's it. Nothing. Ask people with digital how often a bird on the aerial interrupts the programme. You could feed more power into each digital channel, but actually the broadcasters just want to spread it over more channels.

I'll go out on a limb here and suggest that analogue switch-off is also a nail in the coffin for electronic engineering in general. Tell me how many professionals and

enthusiasts first cut their teeth making a basic radio receiver? Maybe I'm stretching a point, but it is just possible for an interested amateur to put together a TV if he really tried, from scratch and first principles.

That is absolutely not possible for digital TV, and who says that radio broadcasts would not eventually go the same way? What happens in a national state of emergency, when some disaster has crippled the communications infrastructure and there is nobody to get a digital TV/radio to work? We could cope if analogue was still available.

### Poorly Explained

Where is the imperative for analogue switch-off coming from? Am I missing something? The Government should at least be called to account by our political opposition, and yet there seems to be no opposition at all. As far as I know, neither the case for nor the case against has formed part of any of the party manifestos leading up to the recent general election.

There has been a general lack of consultation, and the Government should explain to us why they are doing this – in terms other than "wouldn't it be nice if...". They should at the same time explain why on the one hand they wish to get the nation fitter by taking more exercise and becoming involved in community activities, and yet on the other hand be seeking to provide more reasons (?) to be couch potatoes. Perhaps it is some kind of weird reverse logic aversion therapy.

I, for one, am 100% against analogue switch-off. There is no need of additional services beyond what's already available on cable and satellite, and what might be possible with broadband (just another form of cable really).

The publicly funded BBC should focus on putting quality programmes on its core services and forget about expanding into umpteen other channels. If there is a real consumer demand, let private enterprises serve it by whatever means available (Sky, NTL) and charge for it, but leave the existing service alone. I for one will join the ranks of giving up telly altogether if analogue goes – I can't find the time to watch the bits I would like to as it is.

**Ken Wood, via email**

*Editor Mike replied to Ken:*

Thank you for a very interesting letter – I am fully in agreement with you, even though I would like better quality pictures if possible.



## Crossword Update

Dear EPE,

As a result of chatting with several readers I have made some updates to the Crossword Solver (May '05) code. These changes address the following issues:

1. The l.c.d. access routines would not always start properly on powerup. This was due to some critical timing issues associated with using the l.c.d. in 4-bit mode.

2. Words greater than 16 characters had a character missing when displayed.

3. The unit did not reject a request for a word longer than its biggest entry, resulting in rubbish being displayed.

All these are fixed in this release.

**Mike Hibbett, via email**

*Thanks Mike, your new code has been put on our Downloads site and has also been sent to Magenta.*

## TK3 Link to Proton+

Dear EPE,

You may be interested to know that I have produced a *Toolkit TK3* link for PDS. The design of this link was not to modify the *TK3* source code but instead to change the file *TK3settings.txt*. *TK3Link* acts as the programmer by transferring the HEX and ASM files compiled by PDS along with the PIC type used in the code. Once this information has been transferred, *TK3* will be automatically launched. You can download from: [www.thefoxnet.co.uk](http://www.thefoxnet.co.uk).

Your articles have been a great source of inspiration to me over the years, great work, thank you.

**Paul Fox, via email**

*Thanks Paul, that's a great idea implemented. I've also put your code on our Downloads site, in the TK3 folder.*

## CADs Galore

*Robert B. Fairbairn in Readout July '05 was asking about good low-cost CAD software for drawing p.c.b.s, etc. Lots of readers kindly responded, as follows. Thanks everyone.*

Serif DrawPlus is a program which is easy to use and said to be as good as CorelDraw (usual disclaimer). I believe they are up to DrawPlus 9 or 10 now, but a free version of DrawPlus 4 can be downloaded from Serif's website at [www.freerisefsoftware.com/default.asp](http://www.freerisefsoftware.com/default.asp).

**Alan Jones, London**

I have used Microsoft's Visio to produce schematic drawings for support documents whilst working in the UK electricity supply industry. It is fairly intuitive to use and I managed to obtain an OEM (no paper manual) CD ROM of Visio 2000 at a computer fair for around £35 for home use. Coming from the MS stable it has the advantage that it is compatible with Word, Excel, PowerPoint etc. AutoCAD is the de facto CAD standard in most industries, but is quite expensive and (in my experience) is not as intuitive.

**Dave Reeves, Sutton Coldfield**

Freeware software called Eagle should meet Robert's needs. The full version is for

professional applications, but I find the freeware version adequate for most hobbyists, supporting schematic layout and automatic generation of a "rat's nest" to facilitate artwork layout for a double-sided p.c.b. up to 4in x 4in (10cm x 10cm) in size. It also has an extensive library that can be easily expanded. Full details and the freeware download link can be found at [www.cadsoft.de](http://www.cadsoft.de).

**John Harris**

I suggest that Robert takes a look at [www.openoffice.org](http://www.openoffice.org). Their drawing program is extremely good. I have used it on numerous occasions, although I have not drawn a circuit diagram.

**Victor Moisey, University of Cape Town**

I can recommend ePanorama website ([www.epanorama.net/links/software.html](http://www.epanorama.net/links/software.html)) as an excellent resource. This site lists a range of packages in each category, for both Linux and Windows, with prices ranging from the free to the expensive professional packages. Many of the paid-for packages do include free demonstrations, so you can try before you buy.

**Gavin Wheeler, Pembrokeshire**

I recommend Matt Pyne's excellent open source program TinyCad for Windows. This is a full featured schematic design program which is described on Matt's site as follows:

"TinyCAD is a program to help you draw circuit diagrams. It comes complete with symbol libraries to get you started straight away. As well as being able to simply print your designs, you can use TinyCAD to publish your drawings by copying and pasting into a Word document, or saving as a PNG bitmap.

"You can use TinyCAD as a front end to a p.c.b. layout program (see the links), by getting TinyCAD to create a netlist of your circuit. It is fully open-source so you can use it for free and you can download the source code for use in your own projects."

Matt was extremely helpful with my installation problem in Win98 first edition (the latest issue solves the problems I experienced) and the program can export netlists to various freeware programs including SPICE, p.c.b. and stripboard layout software. These can be reached by links from Matt's site: <http://tinycad.sourceforge.net>.

**David Howse**

Provided Robert can access a Linux machine I would suggest he takes a good look at the gEDA suite at [www.geda.seul.org](http://www.geda.seul.org). This is licenced under the GPL and therefore free to download and use. It has a circuit capture program "gshem", a p.c.b. layout program "PCB" and various other related tools. The learning curve is a bit steep but there is an active support group.

A 79MB CD ROM ISO image is available via this site. To show what is possible with this, take a look at <http://dlhamon.com/dspcard/index.html>. This site also has links to some interesting information on reflow soldering of multipin surface mount components using cheap sandwich ovens.

**Colin Ager, Garboldisham, Norfolk**

## Rotary Encoders

Dear EPE,

I'd like to make a suggestion to anyone developing PIC projects. Many PIC projects feature a pair of Up/Down pushbutton switches which are used to set various parameters, the number being displayed on an l.c.d. However, this is not always very user-friendly, particularly if a parameter has to be changed frequently.

Rotary encoders look much like potentiometers, but contain a pair of switches which operate as the control is turned. By counting pulses, a PIC can tell how far the control has been turned, and by watching the order in which the switches operate, the PIC can tell whether the control has rotated clockwise or anti-clockwise. Now instead of pressing a button 30 times, one simply dials up the required number.

Rotary encoders also have the advantages of reducing the number of holes in the front panel, and constructors can choose from a wide range of knobs to give the project the desired appearance.

**Rob Strange, Kenilworth, via email**

*Yes, Rob, the problem of communicating with a PIC can be significant in some cases and a multitude of options are available. A rotary encoder can be one answer, providing its starting position is always known (not actually the case with all such devices).*

## Frequency Calc Prog

Dear EPE,

Looking at July '05 page 483 (*LF and VLF Converter*) there's the usual resonant-frequency formula. Some time ago I wrote an HTML/Javascript program for this calculation. Feel free to invite readers to obtain a copy from me by sending a floppy and stamped/addressed envelope.

**Godfrey Manning, 63 The Drive, Edgware, Middlesex, HA8 8PS.**

*Another useful offering Godfrey, thank you!*

## PC PWM PSU

Dear EPE,

I am building Robert Penfold's *Computer Controlled PWM Power Supply* from June '05. I would be grateful if you could explain to me the reason for using the 4k7 resistor between the emitter of the TIP121 transistor and ground. The article explains that this resistor is required to maintain a significant load on the TIP121. Why is a "significant load" required?

**Noel Dillon, via email**

*Robert explains:*

A power transistor does not usually operate properly unless it passes a current of a milliamp or two. The load resistor simply ensures that this condition is always met. In practice it is likely that there would be sufficient loading on the output anyway. It is only if (say) the output was checked using an oscilloscope or other high resistance load that the load resistor would be required. If you leave it out, the supply will still work properly in most situations.

**Robert Penfold, via email**

# EPE IS PLEASED TO BE ABLE TO OFFER YOU THESE ELECTRONICS CD-ROMS

## ELECTRONICS PROJECTS

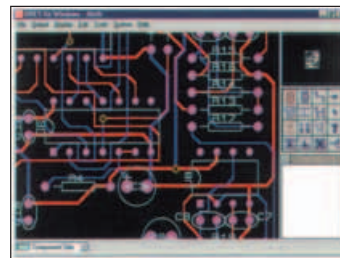


Logic Probe testing

*Electronic Projects* is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK schematic capture, circuit simulation and p.c.b. design software is included.

The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

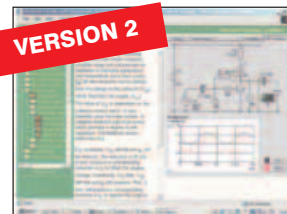
## ELECTRONICS CAD PACK



PCB Layout

Electronics CADPACK allows users to design complex circuit schematics, to view circuit animations using a unique SPICE-based simulation tool, and to design printed circuit boards. CADPACK is made up of three separate software modules. (These are restricted versions of the full Labcenter software.) **ISIS Lite** which provides full schematic drawing features including full control of drawing appearance, automatic wire routing, and over 6,000 parts. **PROSPICE Lite** (integrated into ISIS Lite) which uses unique animation to show the operation of any circuit with mouse-operated switches, pots, etc. The animation is compiled using a full mixed mode SPICE simulator. **ARES Lite** PCB layout software allows professional quality PCBs to be designed and includes advanced features such as 16-layer boards, SMT components, and an autorouter operating on user generated Net Lists.

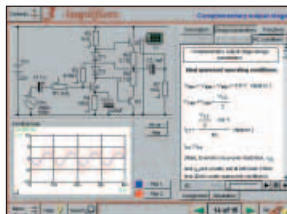
## ELECTRONIC CIRCUITS & COMPONENTS V2.0



Circuit simulation screen

Provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Version 2 has been considerably expanded in almost every area following a review of major syllabuses (GCSE, GNVQ, A level and HNC). It also contains both European and American circuit symbols. Sections include: **Fundamentals**: units & multiples, electricity, electric circuits, alternating circuits. **Passive Components**: resistors, capacitors, inductors, transformers. **Semiconductors**: diodes, transistors, op.amps, logic gates. **Passive Circuits**. **Active Circuits**. **The Parts Gallery** will help students to recognise common electronic components and their corresponding symbols in circuit diagrams. Included in the Institutional Versions are multiple choice questions, exam style questions, fault finding virtual laboratories and investigations/worksheets.

## ANALOGUE ELECTRONICS

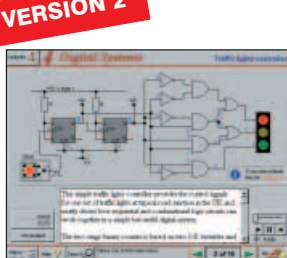


Complimentary output stage

*Analogue Electronics* is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.

Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections), Transistors (4 sections), Waveshaping Circuits (6 sections), **Op.Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections), **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections), **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

## DIGITAL ELECTRONICS V2.0

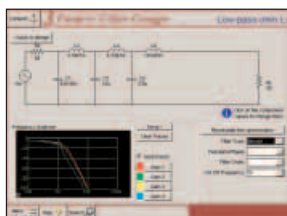


Virtual laboratory – Traffic Lights

*Digital Electronics* builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.

Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units. Sections on Boolean Logic and Venn diagrams, displays and chip types have been expanded in Version 2 and new sections include shift registers, digital fault finding, programmable logic controllers, and microcontrollers and microprocessors. The Institutional versions now also include several types of assessment for supervisors, including worksheets, multiple choice tests, fault finding exercises and examination questions.

## ANALOGUE FILTERS



Filter synthesis

*Analogue Filters* is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev

## ROBOTICS & MECHATRONICS



Case study of the Milford Instruments Spider

Robotics and Mechatronics is designed to enable hobbyists/students with little previous experience of electronics to design and build electromechanical systems. The CD-ROM deals with all aspects of robotics from the control systems used, the transducers available, motors/actuators and the circuits to drive them. Case study material (including the NASA Mars Rover, the Milford Spider and the Furby) is used to show how practical robotic systems are designed. The result is a highly stimulating resource that will make learning, and building robotics and mechatronic systems easier. The Institutional versions have additional worksheets and multiple choice questions.

- Interactive Virtual Laboratories
- Little previous knowledge required
- Mathematics is kept to a minimum and all calculations are explained
- Clear circuit simulations

## PRICES

Prices for each of the CD-ROMs above are:

(Order form on third page)

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

Hobbyist/Student .....	£45 inc VAT
Institutional (Schools/HE/FE/Industry).....	£99 plus VAT
Institutional 10 user (Network Licence) .....	£249 plus VAT
Site Licence.....	£499 plus VAT

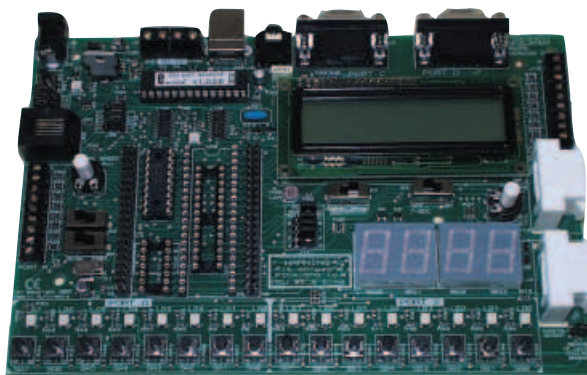


### VERSION 3 PICmicro MCU DEVELOPMENT BOARD

*Suitable for use with the three software packages listed below.*

This flexible development board allows students to learn both how to program PICmicro microcontrollers as well as program a range of 8, 18, 28 and 40-pin devices from the 12, 16 and 18 series PICmicro ranges. For experienced programmers all programming software is included in the PPP utility that comes with the development board. For those who want to learn, choose one or all of the packages below to use with the Development Board.

- Makes it easier to develop PICmicro projects
- Supports low cost Flash-programmable PICmicro devices
- Fully featured integrated displays – 16 individual I.e.d.s, quad 7-segment display and alphanumeric I.c.d. display
- Supports PICmicro microcontrollers with A/D converters
- Fully protected expansion bus for project work
- USB programmable
- Can be powered by USB (no power supply required)



**£158 including VAT and postage**

**supplied with USB cable and programming software**

## SOFTWARE

### NEW V3

*Suitable for use with the Development Board shown above.*

### ASSEMBLY FOR PICmicro V3 (Formerly PICtutor)

Assembly for PICmicro microcontrollers V3.0 (previously known as PICtutor) by John Becker contains a complete course in programming the PIC16F84 PICmicro microcontroller from Arizona Microchip. It starts with fundamental concepts and extends up to complex programs including watchdog timers, interrupts and sleep modes. The CD makes use of the latest simulation techniques which provide a superb tool for learning: the Virtual PICmicro microcontroller. This is a simulation tool that allows users to write and execute MPASM assembler code for the PIC16F84 microcontroller on-screen. Using this you can actually see what happens inside the PICmicro MCU as each instruction is executed which enhances understanding.

- Comprehensive instruction through 45 tutorial sections
- Includes Vlab, a Virtual PICmicro microcontroller: a fully functioning simulator
- Tests, exercises and projects covering a wide range of PICmicro MCU applications
- Includes MPLAB assembler
- Visual representation of a PICmicro showing architecture and functions
- Expert system for code entry helps first time users
- Shows data flow and fetch execute cycle and has challenges (washing machine, lift, crossroads etc.)
- Imports MPASM files.



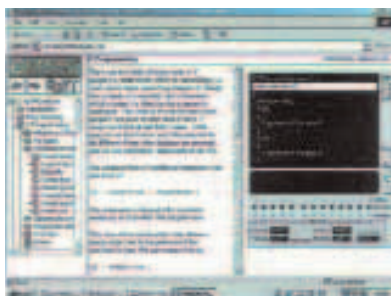
Virtual PICmicro

### 'C' FOR PICmicro VERSION 2

The C for PICmicro microcontrollers CD-ROM is designed for students and professionals who need to learn how to program embedded microcontrollers in C. The CD contains a course as well as all the software tools needed to create Hex code for a wide range of PICmicro devices – including a full C compiler for a wide range of PICmicro devices.

Although the course focuses on the use of the PICmicro microcontrollers, this CD-ROM will provide a good grounding in C programming for any microcontroller.

- Complete course in C as well as C programming for PICmicro microcontrollers
- Highly interactive course
- Virtual C PICmicro improves understanding
- Includes a C compiler for a wide range of PICmicro devices
- Includes full Integrated Development Environment
- Includes MPLAB software
- Compatible with most PICmicro programmers
- Includes a compiler for all the PICmicro devices.



Minimum system requirements for these items: Pentium PC running Windows 98, NT, 2000, ME, XP; CD-ROM drive; 64MB RAM; 10MB hard disk space.

### FLOWCODE FOR PICmicro V2

Flowcode is a very high level language programming system for PICmicro microcontrollers based on flowcharts. Flowcode allows you to design and simulate complex robotics and control systems in a matter of minutes.

Flowcode is a powerful language that uses macros to facilitate the control of complex devices like 7-segment displays, motor controllers and I.c.d. displays. The use of macros allows you to control these electronic devices without getting bogged down in understanding the programming involved.

Flowcode produces MPASM code which is compatible with virtually all PICmicro programmers. When used in conjunction with the Version 2 development board this provides a seamless solution that allows you to program chips in minutes.

- Requires no programming experience
- Allows complex PICmicro applications to be designed quickly
- Uses international standard flow chart symbols (ISO5807)
- Full on-screen simulation allows debugging and speeds up the development process
- Facilitates learning via a full suite of demonstration tutorials
- Produces ASM code for a range of 18, 28 and 40-pin devices
- Professional versions include virtual systems (burglar alarm, buggy and maze, plus RS232, IrDa etc.).



Burglar Alarm Simulation

## PRICES

**Prices for each of the CD-ROMs above are:**

*(Order form on next page)*

*(UK and EU customers add VAT at 17.5% to "plus VAT" prices)*

Hobbyist/Student  
Flowcode V2 Hobbyist/Student  
Institutional (Schools/HE/FE/Industry)  
Flowcode Professional  
Institutional/Professional 10 user (Network Licence)  
Site Licence

£45 inc VAT  
£57 inc VAT  
£99 plus VAT  
£99 plus VAT  
£300 plus VAT  
£599 plus VAT



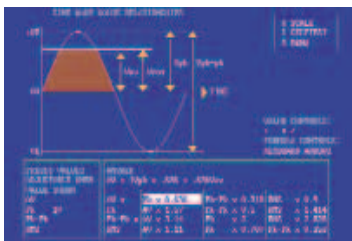
# TEACH-IN 2000 – LEARN ELECTRONICS WITH EPE

EPE's own *Teach-In* CD-ROM, contains the full 12-part *Teach-In* series by John Becker in PDF form plus the *Teach-In* interactive software (Win 95, 98, ME and above) covering all aspects of the series. We have also added Alan Winstanley's highly acclaimed *Basic Soldering Guide* which is fully illustrated and which also includes *Desoldering*. The *Teach-In* series covers: Colour Codes and Resistors, Capacitors, Potentiometers, Sensor Resistors, Ohm's Law, Diodes and L.E.D.s, Waveforms, Frequency and Time, Logic Gates, Binary and Hex Logic, Op.amps, Comparators, Mixers, Audio and Sensor Amplifiers, Transistors, Transformers and Rectifiers, Voltage Regulation, Integration, Differentiation, 7-segment Displays, L.C.D.s, Digital-to-Analogue. Each part has an associated practical section and the series includes a simple PC interface (Win 95, 98, ME ONLY) so you can use your PC as a basic oscilloscope with the various circuits.

A hands-on approach to electronics with numerous breadboard circuits to try out.

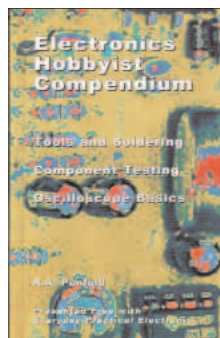
**£12.45 including VAT and postage.** Requires Adobe Acrobat (available free from the Internet – [www.adobe.com/acrobat](http://www.adobe.com/acrobat)).

**FREE WITH EACH TEACH-IN CD-ROM** – *Electronics Hobbyist Compendium* 80-page book by Robert Penfold. Covers Tools For The Job; Component Testing; Oscilloscope Basics.

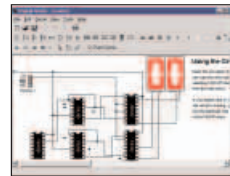


Sine wave relationship values

**FREE BOOK  
WITH TEACH-IN  
2000 CD-ROM**



## DIGITAL WORKS 3.0



Counter project

*Digital Works Version 3.0* is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability. ● Software for simulating digital logic circuits ● Create your own macros – highly scalable ● Create your own circuits, components, and i.c.s ● Easy-to-use digital interface ● Animation brings circuits to life ● Vast library of logic macros and 74 series i.c.s with data sheets ● Powerful tool for designing and learning.

**Hobbyist/Student £45 inc. VAT.**  
**Institutional £99 plus VAT.**  
**Single User £249 plus VAT.**  
**Site Licence £599 plus VAT.**

## ELECTRONIC COMPONENTS PHOTOS

A high quality selection of over 200 JPG images of electronic components. This selection of high resolution photos can be used to enhance projects and presentations or to help with training and educational material. They are royalty free for use in commercial or personal printed projects, and can also be used royalty free in books, catalogues, magazine articles as well as worldwide web pages (subject to restrictions – see licence for full details).

Also contains a **FREE** 30-day evaluation of Paint Shop Pro 6 – Paint Shop Pro image editing tips and on-line help included!

**Price £19.95 inc. VAT**



## ELECTRONICS IN CONTROL

Two colourful animated courses for students on one CD-ROM. These cover Key Stage 3 and GCSE syllabuses. **Key Stage 3:** A pictorial look at the Electronics section featuring animations and video clips. Provides an ideal introduction or revision guide, including multi-choice questions with feedback. **GCSE:** Aimed at the Electronics in many Design & Technology courses, it covers many sections of GCSE Electronics. Provides an ideal revision guide with Homework Questions on each chapter. Worked answers with an access code are provided on a special website.

**Single User £29 inc. VAT. Multiple User £39 plus VAT**  
**Student copies (available only with a multiple user copy) £6 plus VAT**  
**(UK and EU customers add VAT at 17.5% to "plus VAT" prices)**

## MODULAR CIRCUIT DESIGN

Contains a range of tried and tested analogue and digital circuit modules, together with the knowledge to use and interface them. Thus allowing anyone with a basic understanding of circuit symbols to design and build their own projects. Version 3 includes data and circuit modules for a range of popular PICs; includes PICAXE circuits, the system which enables a PIC to be programmed without a programmer, and without removing it from the circuit. Shows where to obtain free software downloads to enable BASIC programming. Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbyists who want to get to grips with project design. Over seventy different Input, Processor and Output modules are illustrated and fully described, together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc.

**Single User £19.95 inc. VAT. Multiple User £34 plus VAT**  
**(UK and EU customers add VAT at 17.5% to "plus VAT" prices)**

**VERSION 3**

Minimum system requirements for these CD-ROMs: Pentium PC, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 95/98/NT/2000/ME/XP, mouse, sound card, web browser.

Please send me:

## CD-ROM ORDER FORM

- ☐ Electronic Projects
- ☐ Electronic Circuits & Components V2.0
- ☐ Analogue Electronics
- ☐ Digital Electronics V2.0
- ☐ Filters
- ☐ Electronics CAD Pack
- ☐ Robotics & Mechatronics
- ☐ Assembly for PICmicro V2
- ☐ 'C' for PICmicro V2
- ☐ Flowcode V2 for PICmicro
- ☐ Digital Works 3.0

Version required:

- ☐ Hobbyist/Student
- ☐ Institutional
- ☐ Institutional/Professional 10 user
- ☐ Site licence



- ☐ PICmicro Development Board V2 (hardware)
- ☐ Development Board UK plugtop power supply
- ☐ Development Board 25-way connecting lead

- ☐ Teach-In 2000 + FREE BOOK
- ☐ Electronic Components Photos
- ☐ Electronics In Control – Single User
- ☐ Electronics In Control – Multiple User
- ☐ Modular Circuit Design – Single User
- ☐ Modular Circuit Design – Multiple User

**Note:** The software on each version is the same, only the licence for use varies.

Full name: .....

Address: .....

Post code: ..... Tel. No: .....

Signature: .....

☐ I enclose cheque/PO in £ sterling payable to WIMBORNE PUBLISHING LTD for £

☐ Please charge my Visa/Mastercard/Amex/Diners Club/Switch: £

Valid From: ..... Card expiry date: .....

Card No: ..... Switch Issue No: .....

Card Security Code ..... (The last 3 digits on or just under the signature strip)

## ORDERING

**ALL PRICES INCLUDE UK POSTAGE**

**Student/Single User/Standard Version price includes postage to most countries in the world**  
**EU residents outside the UK add £5 for airmail postage per order**

**Institutional, Multiple User and Deluxe Versions** – overseas readers add £5 to the basic price of each order for airmail postage (do not add VAT unless you live in an EU (European Union) country, then add 17½% VAT or provide your official VAT registration number).

**Send your order to:**

**Direct Book Service**  
**Wimborne Publishing Ltd**  
**408 Wimborne Road East**  
**Ferndown, Dorset BH22 9ND**

**To order by phone ring**

**01202 873872. Fax: 01202 874562**

**Goods are normally sent within seven days**

**E-mail: [orders@wimborne.co.uk](mailto:orders@wimborne.co.uk)**

**Online shop:**

**[www.epemag.wimborne.co.uk/shopdoor.htm](http://www.epemag.wimborne.co.uk/shopdoor.htm)**

# Back to Basics – CMOS Logic Devices

Bart Trepak

## Part 6 – Daily Reminder and Whistle Switch

Illustrates how useful circuits can be designed simply using CMOS logic devices as the active components

**T**HIS little Daily Reminder gadget has been designed to be a reminder for doing regular events, such as taking medication. It not only indicates the day of the week but also sounds an alarm once each day. When the reset button is pressed, the alarm is cancelled and will not sound again until the following day.

The unit may also be useful as a week-days-only reminder, in which the alarm can be disabled at weekends. Although it is possible to set the day of the week, it is not possible with this simple circuit to set or show the time of day. The day of the week therefore changes and the alarm sounds every 24 hours from the time the unit is first started. It is an easy matter to start the unit at, say, 7.30 a.m. on the first day and it will then continue to sound the alarm at this time every day.

To save battery power, the display is only enabled when a switch is pressed. The alarm, however, will sound each day (unless disabled at weekends) and will sound for one minute unless silenced by pressing the reset switch.

### Basic Operation

The basic operation of the unit is shown in the block diagram of Fig.6.1. The first part is a binary counter which provides the timebase for the circuit, dividing the input frequency to provide one pulse per day.

The clock signal to the counter is indirectly derived from the 50Hz (or 60Hz) a.c. mains frequency. The high input impedance of CMOS devices is used to advantage to pick up the frequency signal without the need for a direct connection to the mains supply. Of course, a mains electricity supply must be within the vicinity!

Since we are not concerned here with seconds or hours, the outputs of the counter are decoded for a count of 4,320,000 (or 5,184,000 for a 60Hz input) which is the number of mains cycles that occur in one day. The output of the decoder is used to reset the counter at the end of this count, following which it begins counting from zero again.

The daily reset pulse is also used to advance a divide-by-seven counter and

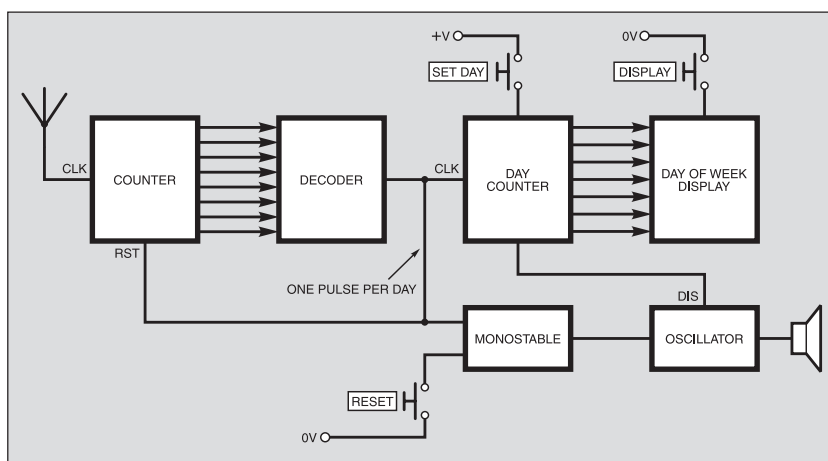
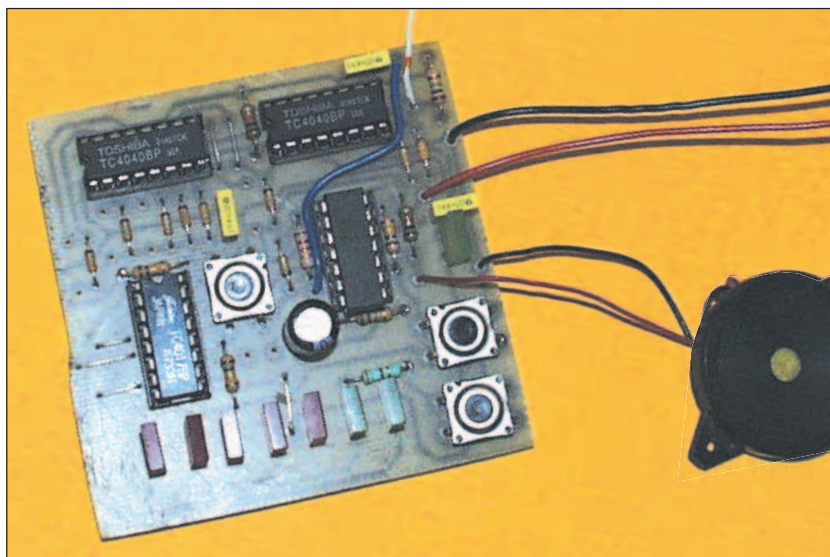


Fig.6.1. Block diagram for the Daily Reminder

the decoded outputs of this drive seven l.e.d.s to provide the day of the week display. It also triggers a monostable which enables an oscillator to sound the alarm for a preset time. The alarm continues until it is acknowledged by pressing the reset switch or the monostable times out.

Alternatively, it is possible to rewire the monostable to function as a bistable, in which case the alarm will sound continuously until disabled by pressing the reset switch. This may be useful in situations where an alarm sounding for only a short period may be missed.



The circuit diagram for the Daily Reminder is shown in Fig.6.2, where counters IC1 and IC2 form the divider chain. Resistor R1 provides additional static protection for the floating input of the circuit.

The very high input impedance of IC1 enables it to respond to the 50Hz mains field normally present around house wiring. If the local field is not strong enough to trigger the counter, the aerial wire (which need only be a few centimetres long) may be wrapped around a nearby mains cable which is permanently energised, such as the power cable to a fridge or freezer.

The two counters form a 24-stage divider which is capable of counting up to 16,777,216 in binary. Table 6.1 shows the number of clock input pulses required for each output to go high for the first time following a reset, so that Q12 (the last output of IC1) for example, will first go high after 2048 input pulses while Q24 (the last output of IC2) would not go high until 8,388,608 clock pulses had been counted, although in this circuit this will never occur.

Selected outputs of the counter are connected to an 8-input wired-AND

<i>Output</i>	<i>Ratio</i>	<i>50Hz</i>	<i>60Hz</i>
Q1	1		
Q2	2		
Q3	4		
Q4	8		
Q5	16		
Q6	32		
Q7	64		
Q8	128		
Q9	256	★	
Q10	512	★	#
Q11	1024		
Q12	2048	★	#
Q13	4096		#
Q14	8192	★	
Q15	16384	★	
Q16	32768	★	
Q17	65536	★	#
Q18	131072		#
Q19	262144		#
Q20	524288		#
Q21	1048576		
Q22	2097152		
Q23	4194304	★	#
Q24	8388608		

*Everyday Practical Electronics, September 2005*



# COMPONENTS

## DAILY REMINDER

### Resistors

R1, R5	1M (2 off)
R2, R3, R6,	
R9	100k (4 off)
R4, R7	10k
R8	390Ω

All 0.25W 5% carbon film

### Capacitors

C1, C3, C4	100n ceramic disc, 5mm pitch (3 off)
C2, C5	100μ axial elect. 16V (2 off)

### Semiconductors

D1 to D9	1N4148 signal diode (9 off)
D10 to D17	red or green l.e.d. (8 off)
IC1, IC2	4040 binary ripple counter (2 off)
IC3	4017 decade counter
IC4	4093 quad Schmitt NAND gate

### Miscellaneous

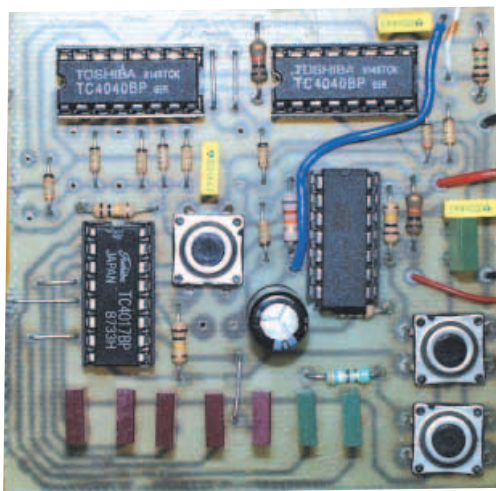
S1, S3, S4	min. push-to-make switch, p.c.b. mounting (3 off)
S2	see text
WD1	piezo sounder (passive)

See  
SHOP  
TALK  
page

Printed circuit board, available from the *EPE PCB Service*, code 527; 14-pin d.i.l. socket, 16-pin d.i.l. socket (3 off); 9V battery and connector, connecting wire; solder, etc.

Approx. Cost  
Guidance Only

**£15**  
excl case and  
batts



gate, formed by diodes D1 to D8 plus resistor R3. Since these will all be switching high and low at various times, the output of this AND gate will normally hold IC4a input pins 1 and 2 low since at least one output of the counter will be low at any one time.

After 4,320,000 clock pulses, however, all of the selected outputs will be high together for the first time, so that the output of the AND gate will go high.

In theory, this output could be used to reset the counters, but in practice if one counter (or even one stage in the chain)

In this circuit, therefore, the output of the AND gate is connected to IC4a, which functions as an inverter so that its output goes low when the above count is reached. This sets the monostable formed by IC4b and IC4c, causing the output of IC4c to go high, resetting the counter chain via capacitor C1. The C1/R4 combination ensures that a pulse long enough to reset both counters is produced, after which they start counting from zero all over again.

With the counters reset, the output of the AND gate goes low again and the output of

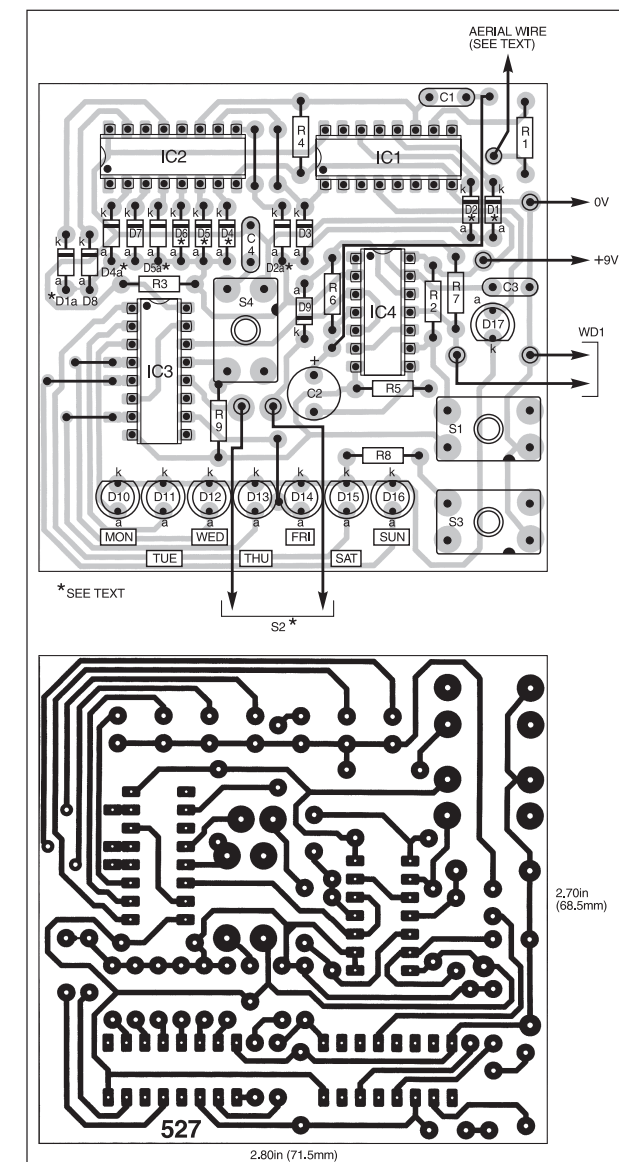


Fig.6.3. Printed circuit board component layout, wiring details and full-size copper foil master for the Daily Reminder

responds to the reset pulse faster than the others and its output goes to zero, the output of the AND gate would go low again, which could result in a partial reset of the counter.

IC4a goes high, triggering the 4017 decade counter, IC3, causing its next output (e.g. Q1, Tuesday) to go high, and its previous output (e.g. Q0, Monday) to go low. This is indicated on the respective l.e.d. (D10 to D16) when the display switch S3 is pressed.

Output Q7 of the 4017 counter is connected to its reset input so that after Q6 (Sunday) the counter will be reset and output Q0 (Monday) will go high.

Since the clock input of IC3 is mostly held high, the counter can also be advanced on the negative transition of the CI input and this is used as a convenient way of setting the day display as required, using switch S4. Note that the counter will advance each time S4 is released rather than when it is pressed.

## Weekend Break

The COUT (carry) output is also used in this circuit. This output is high when outputs Q0 to Q4 are high, but goes low when Q5 or above is high. This is the case when

the Q5 or Q6 (Saturday and Sunday) outputs are reached and so this output thus forms a convenient "weekend" output.

When the output of IC4c goes high, the oscillator formed by IC4d is enabled, sounding the alarm and alerting the user that a "new day" has begun (dependent on the time that the unit is first switched on).

If switch S2 is closed, however, diode D8 will ensure that the oscillator remains disabled at weekends because the low logic level at COUT will prevent the control input from going high. In this way the alarm can be disabled during weekends in applications that require this.

Once the alarm is sounding, it can be silenced by pressing switch S1, which resets the monostable IC4b/IC4c and disables the oscillator. If this is not done, the alarm will switch off automatically after a time determined by capacitor C2 and resistor R5, which with the component values shown will be around 70 seconds.

This period may be extended by increasing the value of C2 or R5, or made indefinite by replacing C2 with a wire link. This will effectively change the monostable built around IC4b/IC4c into a bistable and cause the alarm to sound continuously until silenced by pressing S1.

## Construction

Printed circuit board component layout and track details for the Daily Reminder are shown in Fig.6.3. This board is available from the *EPE PCB Service*, code 527.

All of the components (with the exception of the sounder and battery) are mounted on the board. This includes the

push-to-make switches S1, S3 and S4, while S2 is implemented as a wire link which should be fitted if the alarm is not required at weekends. In applications where this requirement could change often, a miniature slide or toggle switch could be fitted on flying leads instead.

Care should be taken to ensure that all of the diodes are connected the correct way around. The layout diagram shows the position of the diodes D1 to D8 required for correct operation with a 50Hz mains frequency.

Connections are provided on the p.c.b. to position the diodes for 60Hz operation if required and this will involve *not* fitting diodes D1, D4, D5 and D6 as shown but in the alternative positions instead, numbered with an "a" suffix. Diodes D2, D3, D7 and D8 should remain in the positions shown for 50Hz operation.

Normal precautions regarding static electricity should be observed with the i.c.s and these should be fitted into sockets rather than soldered directly to the board. The piezo sounder WD1 should be soldered to the pads provided and here, although it may have black and red leads, the orientation is not important.

A short piece of sleeved copper wire should be soldered to the pad provided to act as an "aerial". A single core wire is better for this because it is stiffer and may be wrapped around a mains cable more easily should this be required.

Seven links are required in the layout and these can be made from discarded component leads, except the long one (between C1 and R6). This should be

made from a suitable length of insulated wire to prevent unintended connections to components along its length.

## Testing

When assembly is complete and fully checked, a battery should be connected and the Display switch (S3) pressed. The Monday l.e.d. should be lit and l.e.d. D17 should flash at around 1Hz. If D17 does not light, the aerial should be placed close to a mains field such as exists around the power cable to an appliance.

In some cases, the aerial may need to be wrapped around the cable a few times to give reliable results. It does not matter if the appliance is switched on or not as long as it is plugged in and the supply is *not* switched off at the socket. In this respect it is therefore best to utilise an appliance which is never switched off, such as a fridge/freezer.

Once D17 is flashing, Set Day switch S4 should be pressed repeatedly until the correct day is displayed (S3 should be kept pressed to enable the display). The setting up is now complete and the circuit will sound the alarm every 24 hours from this time. Switch S1 should be pressed to cancel the alarm after it has sounded.

Since the circuit will only sound the alarm after 24 hours, which is a rather inconveniently long time to spend testing the rest of the unit, things may be speeded up somewhat by temporarily removing IC2. This will cause the display to change and the alarm to sound after only 2816 input pulses, or about 56 seconds with a 50Hz input enabling the operation of the unit to be checked rather more quickly.

# Whistle Switch

**M**OST modern remote controls use either infra-red or radio as the transmission medium because there are fewer natural interference sources of such radiation to upset the working of the system. They do, however, all have the major disadvantage in that a special transmitter is required to operate the link.

The system to be described here differs in that it uses sound as the medium so that no special transmitter is required. Unlike most sound-operated switches, which can be triggered by any sound of sufficient amplitude, this circuit is sensitive only to sound in a relatively narrow frequency band. It is specifically designed to respond to a whistle and will therefore ignore many naturally occurring sounds of other frequencies.

The frequency range to which the unit responds can be made quite small, allowing a number of units to be used in the same area. The sensitivity is such that operation from another room is possible. In practice, however, the difficulty in producing a whistle of exactly the right frequency means that the frequency range to which the receiver responds has to be broadened somewhat, thus limiting the possible number of independent receivers.

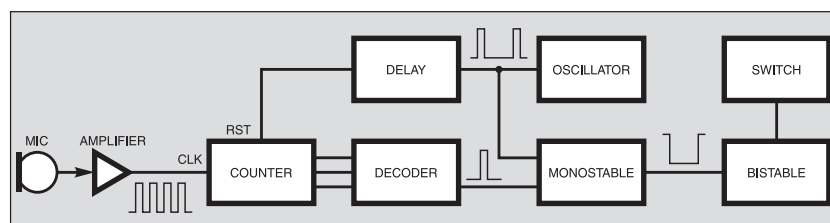


Fig.6.4 Whistle Switch block schematic diagram

For those who have difficulty in whistling, a simple tin whistle can provide a handy transmitter.

A relay, RLA, allows external devices to be controlled by this unit. ***Note though that a.c. mains powered devices should only be connected by those who are suitably qualified or supervised.***

## Basic Operation

A block diagram of the Whistle Switch is shown in Fig.6.4.

The input signal is picked up by a microphone and amplified before being applied to the clock input of a counter. The counter circuit assesses whether the frequency is within a certain range. Although

the circuit could be designed to determine the frequency quite accurately, in this application it would not be desirable as few people are able to whistle consistently at a given pitch.

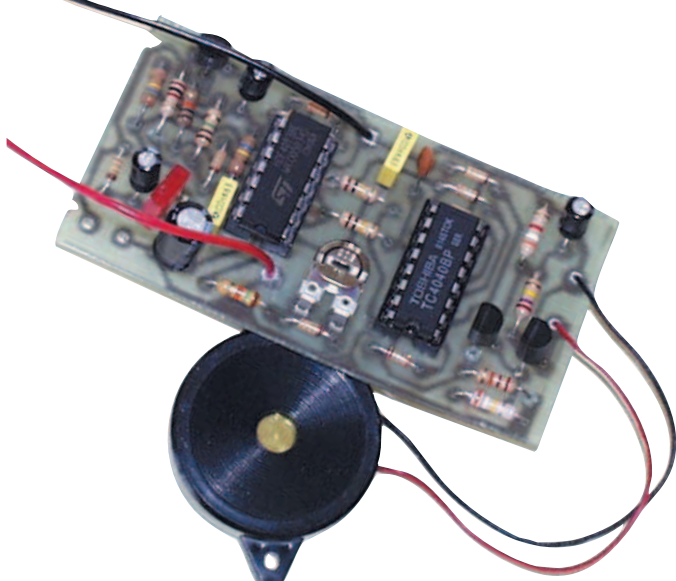
The counter's measurement cycle is controlled by an oscillator which periodically resets the counter to initiate the next measurement. The counter is coupled to a decoder which determines if the expected count is received within a given time.

The output of the decoder is sampled at the end of each measurement period by a re-triggerable monostable. This ensures that only one output transition is obtained during each whistle command, which may extend over a number of measurement



The width of the decoder window may be made narrower by adding diode D4 to the decoder so that its output will go high only after 28 (but less than 32) input pulses have been detected, or wider by leaving out D3, producing an output after 16 clock pulses. Decoding counter outputs Q2 and Q1 could make the window narrower still, but in this application this would require a very





R8, but when a correct frequency whistle is detected and the output of IC2b goes low, C4 is quickly discharged via diode D6. Provided the whistle continues to be received, C4 is unable to recharge via R8 and the voltage across it remains low. This low logic level is applied to the input of the bistable formed by the remaining gates IC2c, IC2d and transistor TR3, which also serves as a relay driver.

### Bistable

If IC2d inputs 12 and 13 are high, its output will be low and TR3 switched off causing its collector (c) to be high. This will keep IC2d's inputs high via feedback resistor R12 and the circuit will remain in this state indefinitely. If on the other hand IC2d's inputs go low, its output will go high, TR3 will switch on and its low collector voltage will keep IC2d input low so that the circuit will also be stable in this state.

Assuming that the inputs of IC2d are high (relay off), when the voltage across C4 goes low, capacitors C5 and C6 charge via R9 and R10, causing the voltage at IC2c and IC2d inputs to fall. The charging resistors are equal in value, but since C6 has a much smaller value than C5, the voltage at IC2d's inputs will fall much faster and will reach the lower logic threshold first. Consequently, IC2d's out-

put will switch high, turning on TR3 and energising the relay.

If the whistle now ceases, the voltage across C4 will rise, C5 and C6 will discharge and the circuit will remain in this new state. If another short whistle is now detected the process would be repeated and the output state would not change. However, if the whistle now lasts long enough for the voltage across C5 to reach the lower logic threshold of IC2c, its output will go high and discharge C6 via D7,

precise whistle frequency to operate the unit.

If more than 31 input pulses occur before the reset pulse (i.e. the input frequency is too high), outputs Q1 to Q5 will go low and output Q6 will go high. This will "short out" R4 via diode D1 preventing further input pulses from being counted so that the output of the decoder will remain low and prevent IC2b generating an output pulse when the reset pulse occurs. Higher whistle frequencies will therefore also be ignored.

The time between reset pulses, and thus the range of input frequencies which will be detected, can be varied by means of preset VR1 which sets the frequency of the oscillator.

When the output of IC2b is high, capacitor C4 is charged at the rate set by resistor

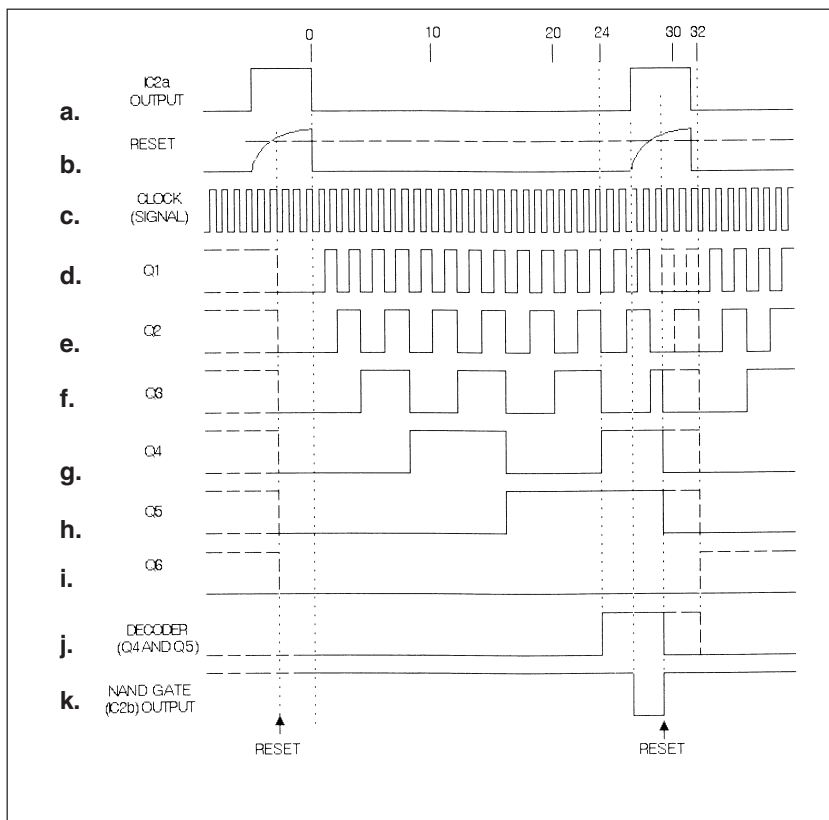


Fig.6.6. Whistle Switch circuit waveforms

## COMPONENTS

### WHISTLE SWITCH

#### Resistors

R1	270k
R2	390k
R3	3k9
R4	22k
R5, R6	100k (2 off)
R7	15k
R8, R12	1M (2 off)
R9, R10	560k (2 off)
R11	10k
R13	1k

All 0.25W 5% carbon film

#### Potentiometer

VR1	1M skeleton preset
-----	--------------------

#### Capacitors

C1	10μ radial elect. 16V
C2	1n ceramic disc, 5mm pitch
C3, C6	100n ceramic disc, 5mm pitch (2 off)
C4, C5	2μ2 radial elect. 16V (2 off)
C7	100μ radial elect. 16V

#### Semiconductors

D1 to D7	1N4148 signal diode (7 off)
D8	1N4001 rect. diode red l.e.d.
D9	red l.e.d.
TR1 to TR3	2N3904 npn transistor (3 off)
IC1	4040 12-stage ripple counter
IC2	4093 quad Schmitt NAND gate

#### Miscellaneous

MIC1	piezo element disc, passive
RLA	relay (see text)
S1	s.p.d.t. toggle switch

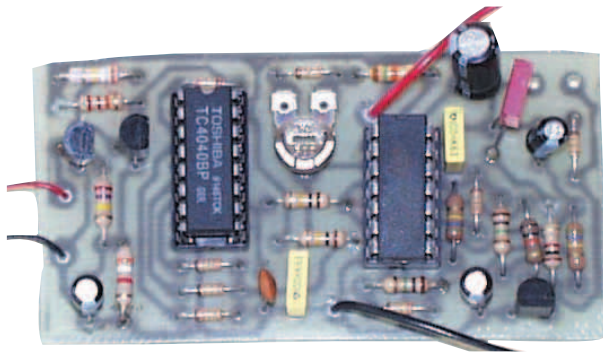


Printed circuit board, available from the EPE PCB Service, code 528; 14-pin d.i.l. socket, 16-pin d.i.l. socket (3 off); 9V battery and connector (see text), connecting wire; solder, etc.

Approx. Cost  
Guidance Only

**£12**

excl case, relay  
and batts



Completed prototype Whistle Switch circuit board. The two unconnected pads at the top right go to the relay coil

forcing IC2d input high thus switching the relay off.

The relay can therefore be switched on by means of a short whistle, while a longer one will switch the relay off. Indication of the relay's state is provided by l.e.d. D9, which is buffered by R13.

Diode D8 inhibits back-e.m.f. generation when the relay switches off.

## Construction

Printed circuit board component layout and track details for the Whistle Switch are shown in Fig.6.7. This board is available from the *EPE PCB Service*, code 528.

Construction should proceed with normal precautions being taken to observe the correct polarity of semiconductors and electrolytic capacitors. The polarity of the piezo sounder is unimportant. Observe the normal antistatic precautions when handling the i.c.s. Do not insert the i.c.s. until the board has been fully checked for errors.

The type of relay fitted will depend on the type of load to be controlled and the output contacts should be rated to handle the current and voltage to be switched. The relay coil should be connected to the circuit board with flying leads and diode D8 fitted on the board.

The circuit will operate from a range of voltages from 5V to 12V and the relay should be chosen for the voltage used, although in practice most relays will operate from a range of voltages. Higher resistance coils are to be preferred as these will draw less current.

The circuit draws less than 1mA from a 9V supply, but this rises substantially when a relay is switched on so that in most applications a small d.c. mains adapter will be a more practical proposition.

## Testing

The circuit may be tested using a battery supply. A relay need not be fitted at this stage as l.e.d. D9 will indicate its correct operation. If an oscilloscope is not available should fault finding be needed, a digital voltmeter connected across capacitor C4 can indicate when a whistle in the correct frequency range has been detected.

The upper voltage across C4 varies with the supply voltage, but it will be seen to fall to below 2V when a correct frequency whistle is received. Adjust preset VR1 until the circuit responds, with l.e.d. D9 turning on and off accordingly.

Because of the relatively high values of resistance in the circuit, the capacitors in the bistable can take a few moments to charge or discharge between operations. This means that the circuit cannot be switched on and off in quick succession. This is not a problem in normal use but should be borne in mind when testing the unit.

The completed unit should be mounted in a suitable box and the choice of this will be dictated as much by personal preference as by the application to which the unit is to be put. Remember to leave a hole near the microphone to allow the sound to enter.

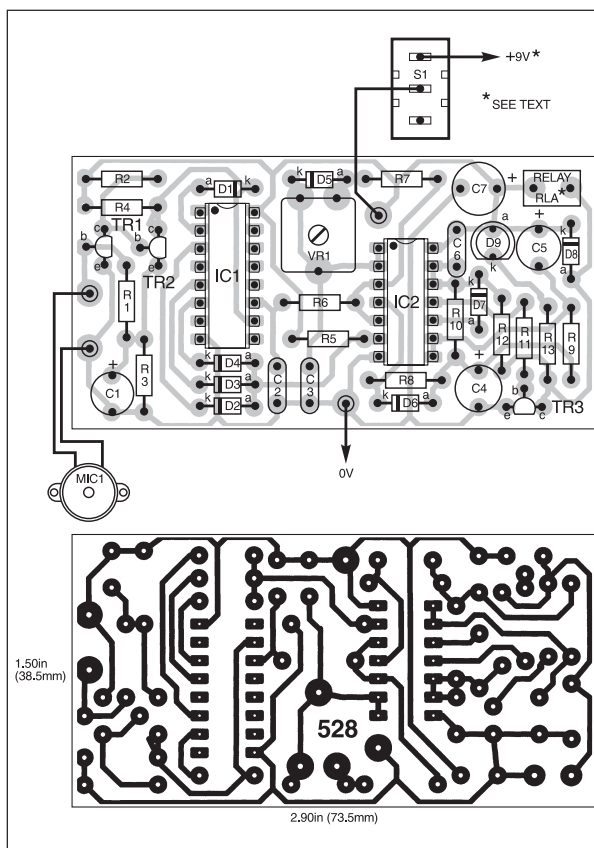


Fig.6.7. Whistle Switch printed circuit board component layout, wiring and full-size copper foil master

**ANDRE LAMOTHE'S**  
**XGAMESTATION**  
 LEARN STEP-BY-STEP HOW TO DESIGN  
 AND BUILD YOUR OWN VIDEO GAME CONSOLE!  
 Design inspired by the Atari 800, 2600,  
 Sinclair ZX Spectrum, Apple II & Commodore 64!

Complete Package eBook Integrated IDE

SX32 CPU  
 80 MIPS!

OPEN-SOURCE!

**FEATURES:**

- Great for Hobbyists AND Students!
- Complete Software Development KIT!
- eBook on Designing the XGS Console!
- Parallax SX-Key Compatible!
- Fully Assembled XGS Micro Edition Unit!
- The Fun Way to Learn Embedded Systems!

PAL & NTSC  
 COMPATIBLE!

WWW.XGAMESTATION.COM  
 SUPPORT@NURVE.NET | PH 925.736.2098 (USA)

**EPE**  
 online  
[www.epemag.com](http://www.epemag.com)

Get your magazine "instantly" anywhere in the world – buy and download from the web.

**TAKE A LOOK, A FREE ISSUE IS AVAILABLE**

A one year subscription (12 issues) costs just \$14.99 (US)

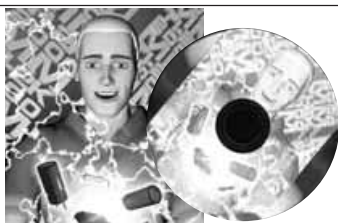
[www.epemag.com](http://www.epemag.com)



# DIRECT BOOK SERVICE

NOTE: ALL PRICES INCLUDE UK POSTAGE

FREE *Electronics Hobbyist Compendium*  
book with Teach-In 2000 CD-ROM



## EPE TEACH-IN 2000 CD-ROM

The whole of the 12-part *Teach-In 2000* series by John Becker (published in *EPE* Nov '99 to Oct 2000) is now available on CD-ROM. Plus the *Teach-In 2000* interactive software (Win 95, 98, ME and above) covering all aspects of the series and Alan Winstanley's *Basic Soldering Guide* (including illustrations and Desoldering).

*Teach-In 2000* covers all the basic principles of electronics from Ohm's Law to Displays, including Op.Amps, Logic Gates etc. Each part has its own section on the interactive software where you can also change component values in the various on-screen demonstration circuits.

The series gives a hands-on approach to electronics with numerous breadboard circuits to try out, plus a simple computer interface (Win 95, 98, ME only) which allows a PC to be used as a basic oscilloscope.

ONLY **£12.45** including VAT and p&p

Order code Teach-In CD-ROM

## Circuits and Design

### PREAMPLIFIER AND FILTER CIRCUITS

R. A. Penfold

Provides circuits and background information for a range of preamplifiers, plus tone controls, filters, mixers, etc. The use of modern low noise operational amplifiers and a specialist high performance audio preamplifier i.e. results in circuits that have excellent performance, but which are still quite simple. All the circuits featured can be built at quite low cost. The preamplifier circuits featured include: Microphone preamplifiers (low impedance, high impedance, and crystal). Magnetic cartridge pick-up preamplifiers with R.I.A.A. equalisation. Crystal/ceramic pick-up preamplifier. Guitar pick-up preamplifier. Tape head preamplifier.

Other circuits include: Audio limiter. Passive tone controls. Active tone controls. PA filters (highpass and lowpass). Scratch and rumble filters. Loudness filter. Mixers. Volume and balance controls.

92 pages

Temporarily out of print

### MICROCONTROLLER COOKBOOK

Mike James

The practical solutions to real problems shown in this cookbook provide the basis to make PIC and 8051 devices really work. Capabilities of the variants are examined, and ways to enhance these are shown. A survey of common interface devices, and a description of programming models, lead on to a section on development techniques. The cookbook offers an introduction that will allow any user, novice or experienced, to make the most of microcontrollers.

240 pages

Order code NE26

£23.99

### A BEGINNER'S GUIDE TO TTL DIGITAL ICs

R. A. Penfold

This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world".

142 pages

Order code BP332

£5.45

### PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Bridges the gap between complicated technical theory, and "cut-and-try" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias – tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-Current Circuits, Passive Components, Alternating-Current Circuits, Networks and Theorems, Measurements.

256 pages

Order code BP53

£5.49

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

FOR A FURTHER  
SELECTION OF BOOKS  
SEE THE NEXT TWO  
ISSUES OF *EPE*

All prices include UK  
postage

### WINDOWS XP EXPLAINED

N. Kantaris and P. R. M. Oliver

If you want to know what to do next when confronted with Microsoft's Windows XP screen, then this book is for you. It applies to both the Professional and Home editions. The book was written with the non-expert, busy person in mind. It explains what hardware requirements you need in order to run Windows XP successfully, and gives an overview of the Windows XP environment.

The book explains: How to manipulate Windows, and how to use the Control Panel to add or change your printer, and control your display; How to control information using WordPad, Notepad and Paint, and how to use the Clipboard facility to transfer information between Windows applications; How to be in control of your filing system using Windows Explorer and My Computer; How to control printers, fonts, characters, multimedia and images, and how to add hardware and software to your system; How to configure your system to communicate with the outside world, and use Outlook Express for all your email requirements; How to use the Windows Media Player 8 to play your CDs, burn CDs with your favourite tracks, use the Radio Tuner, transfer your videos to your PC, and how to use the Sound Recorder and Movie Maker; How to use the System Tools to restore your system to a previously working state, using Microsoft's Website to update your Windows set-up, how to clean up, defragment and scan your hard disk, and how to backup and restore your data; How to successfully transfer text from those old but cherished MS-DOS programs.

268 pages

Order code BP514

£7.99

### INTRODUCING ROBOTICS WITH LEGO MINDSTORMS

Robert Penfold

Shows the reader how to build a variety of increasingly sophisticated computer controlled robots using the brilliant Lego Mindstorms Robotic Invention System (RIS). Initially covers fundamental building techniques and mechanics needed to construct strong and efficient robots using the various "click-together" components supplied in the basic RIS kit. Explains in simple terms how the "brain" of the robot may be programmed on screen using a PC and "zapped" to the robot over an infra-red link. Also, shows how a more sophisticated Windows programming language such as Visual BASIC may be used to control the robots.

Detailed building and programming instructions provided, including numerous step-by-step photographs.

288 pages – large format

Order code BP901

£14.99

### MORE ADVANCED ROBOTICS WITH LEGO MINDSTORMS – Robert Penfold

Covers the Vision Command System

Shows the reader how to extend the capabilities of the brilliant Lego Mindstorms Robotic Invention System (RIS) by using Lego's own accessories and some simple home constructed units. You will be able to build robots that can provide you with "waiter service" when you clap your hands, perform tricks, "see" and avoid objects by using "bats radar", or accurately follow a line marked on

the floor. Learn to use additional types of sensors including rotation, light, temperature, sound and ultrasonic and also explore the possibilities provided by using an additional (third) motor. For the less experienced, RCX code programs accompany most of the featured robots. However, the more adventurous reader is also shown how to write programs using Microsoft's VisualBASIC running with the ActiveX kit (Spirit.OCX) that is provided with the RIS kit.

Detailed building instructions are provided for the featured robots, including numerous step-by-step photographs. The designs include rover vehicles, a virtual pet, a robot arm, an "intelligent" sweet dispenser and a colour conscious robot that will try to grab objects of a specific colour.

298 pages

Order code BP902

£14.99

### PIC YOUR PERSONAL INTRODUCTORY COURSE SECOND EDITION John Morton

Discover the potential of the PIC microcontroller through graded projects – this book could revolutionise your electronics construction work!

A uniquely concise and practical guide to getting up and running with the PIC Microcontroller. The PIC is one of the most popular of the microcontrollers that are transforming electronic project work and product design.

Assuming no prior knowledge of microcontrollers and introducing the PICs capabilities through simple projects, this book is ideal for use in schools and colleges. It is the ideal introduction for students, teachers, technicians and electronics enthusiasts. The step-by-step explanations make it ideal for self-study too: this is not a reference book – you start work with the PIC straight away.

The revised second edition covers the popular reprogrammable EEPROM PICs: P16C84/16F84 as well as the P54 and P71 families.

270 pages

Order code NE36

£15.99

### INTRODUCTION TO MICROPROCESSORS

John Crisp

If you are, or soon will be, involved in the use of microprocessors, this practical introduction is essential reading. This book provides a thoroughly readable introduction to microprocessors, assuming no previous knowledge of the subject, nor a technical or mathematical background. It is suitable for students, technicians, engineers and hobbyists, and covers the full range of modern microprocessors.

After a thorough introduction to the subject, ideas are developed progressively in a well-structured format. All technical terms are carefully introduced and subjects which have proved difficult, for example 2's complement, are clearly explained. John Crisp covers the complete range of microprocessors from the popular 4-bit and 8-bit designs to today's super-fast 32-bit and 64-bit versions that power PCs and engine management systems etc.

222 pages

Order code NE31

£21.99

### NEWNES PC TROUBLESHOOTING POCKET BOOK – THIRD EDITION

Howard Anderson, Mike Tooley

All the essential data for PC fault-finding and upgrading. This book provides a concise and compact reference that describes, in a clear and straightforward manner, the principles and practice of fault-finding and upgrading PCs and peripherals. The book is aimed at anyone who is involved with the installation, configuration, maintenance, upgrading, repair or support of PC systems. It also provides non-technical users with sufficient background information, charts and checklists to enable the diagnosis of faults and help to carry out simple modifications and repairs. In order to reflect rapid changes in computer technology (both hardware and software) this new edition has been completely revised and rewritten.

256 pages

Order code NE41

£19.99

### NEWNES INTERFACING COMPANION

Tony Fischer-Cripps

A uniquely concise and practical guide to the hardware, applications and design issues involved in computer interfacing and the use of transducers and instrumentation.

Newnes Interfacing Companion presents the essential information needed to design a PC-based interfacing system from the selection of suitable transducers, to collection of data, and the appropriate signal processing and conditioning.

Contents: Part 1 – Transducers; Measurement systems; Temperature; Light; Position and motion; Force, pressure and flow. Part 2 – Interfacing; Number systems; Computer architecture; Assembly language; Interfacing: A to D and D to A; Conversions; Data communications; Programmable logic controllers; Data acquisition project. Part 3 – Signal processing; Transfer function; Active filters; Instrumentation amplifier; Noise; Digital signal processing.

320 pages

Order code NE38

£26.99



# Testing, Theory and Reference

## THE AMATEUR SCIENTIST CD-ROM

The complete collection of The Amateur Scientist articles from *Scientific American* magazine. Over 1,000 classic science projects from a renowned source of winning projects. All projects are rated for cost, difficulty and possible hazards.

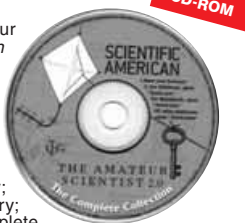
Plus over 1,000 pages of helpful science techniques that never appeared in *Scientific American*.

Exciting science projects in: Astronomy; Earth Science; Biology; Physics; Chemistry; Weather . . . and much more! The most complete resource ever assembled for hobbyists, and professionals looking for novel solutions to research problems. Includes extensive Science Software Library with even more science tools.

Suitable for Mac, Windows, Linux or UNIX. 32MB RAM minimum, Netscape 4.0 or higher or Internet Explorer 4.0 or higher. Over 1,000 projects

Order code AS1 CD-ROM

£19.95



## BEBOP BYTES BACK (and the Beboputer Computer Simulator) CD-ROM

Clive (Max) Maxfield and Alvin Brown

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the CD-ROM contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the CD-ROM contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this!

Over 800 pages in Adobe Acrobat format

Order code BEB2 CD-ROM

£21.95



## DIGITAL ELECTRONICS – A PRACTICAL APPROACH With FREE Software: Number One Systems – EASY-PC Professional XM and Pulsar (Limited Functionality) Richard Monk

Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus the additional attraction of its close association with computer-aided design including the FREE software.

There is a 'blow-by-blow' guide to the use of EASY-PC Professional XM (a schematic drawing and printed circuit board design computer package). The guide also conducts the reader through logic circuit simulation using Pulsar software. Chapters on p.c.b. physics and p.c.b. production techniques make the book unique, and with its host of project ideas make it an ideal companion for the integrative assignment and common skills components required by BTEC and the key skills demanded by GNVQ. The principal aim of the book is to provide a straightforward approach to the understanding of digital electronics.

Those who prefer the 'Teach-In' approach or would rather experiment with some simple circuits should find the book's final chapters on printed circuit board production and project ideas especially useful.

250 pages

Temporarily out of print

## OSCILLOSCOPES – FIFTH EDITION Ian Hickman

Oscilloscopes are essential tools for checking circuit operation and diagnosing faults, and an enormous range of models are available.

This handy guide to oscilloscopes is essential reading for anyone who has to use a 'scope for their work or hobby; electronics designers, technicians, anyone in industry involved in test and measurement, electronics enthusiasts . . . Ian Hickman's review of all the latest types of 'scope currently available will prove especially useful for anyone planning to buy – or even build – an oscilloscope.

The contents include a description of the basic oscilloscope; Advanced real-time oscilloscope; Accessories; Using oscilloscopes; Sampling oscilloscopes; Digital storage oscilloscopes; Oscilloscopes for special purposes; How oscilloscopes work (1): the CRT; How oscilloscopes work (2): circuitry; How oscilloscopes work (3): storage CRTs; plus a listing of Oscilloscope manufacturers and suppliers.

288 pages

Order code NE37

£22.99

## SCROGGIE'S FOUNDATIONS OF WIRELESS AND ELECTRONICS – ELEVENTH EDITION S. W. Amos and Roger Amos

Scroggie's Foundations is a classic text for anyone working with electronics, who needs to know the art and craft of the subject. It covers both the theory and practical aspects of a huge range of topics from valve and tube technology, and the application of cathode ray tubes to radar, to digital tape systems and optical recording techniques.

Since *Foundations of Wireless* was first published over 60 years ago, it has helped many thousands of readers to become familiar with the principles of radio and electronics. The original author Sowerby was succeeded by Scroggie in the 1940s, whose name became synonymous with this classic primer for practitioners and students alike. Stan Amos, one of the fathers of modern electronics and the author of many well-known books in the area, took over the revision of this book in the 1980s and it is he, with his son, who have produced this latest version.

400 pages

Temporarily out of print

## PRACTICAL ELECTRONIC FAULT FINDING AND TROUBLESHOOTING Robin Pain

To be a real fault finder, you must be able to get a feel for what is going on in the circuit you are examining. In this book Robin Pain explains the basic techniques needed to be a fault finder.

Simple circuit examples are used to illustrate principles and concepts fundamental to the process of fault finding. This is not a book of theory, it is a book of practical tips, hints and rules of thumb, all of which will equip the reader to tackle any job. You may be an engineer or technician in search of information and guidance, a college student, a hobbyist building a project from a magazine, or simply a keen self-taught amateur who is interested in electronic fault finding but finds books on the subject too mathematical or specialised.

The fundamental principles of analogue and digital fault finding are described (although, of course, there is no such thing as a "digital fault" – all faults are by nature analogue). This book is written entirely for a fault finder using only the basic fault-finding equipment: a digital multimeter and an oscilloscope. The treatment is non-mathematical (apart from Ohm's law) and all jargon is strictly avoided.

274 pages

Temporarily out of print

## ELECTRONIC TEST EQUIPMENT HANDBOOK Steve Money

In most applications of electronics, test instruments are essential for checking the performance of a system or for diagnosing faults in operation, and so it is important for engineers, technicians, students and hobbyists to understand how the basic test instruments work and how they can be used.

The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of these instruments are also examined.

206 pages

Order code PC109

£9.95

## DIGITAL GATES AND FLIP-FLOPS Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages

Order code PC106

£9.95

## UNDERSTANDING ELECTRONIC CONTROL SYSTEMS Owen Bishop

Owen Bishop has produced a concise, readable text to introduce a wide range of students, technicians and professionals to an important area of electronics. Control is a highly mathematical subject, but here maths is kept to a minimum, with flow charts to illustrate principles and techniques instead of equations.

Cutting edge topics such as microcontrollers, neural networks and fuzzy control are all here, making this an ideal refresher course for those working in Industry. Basic principles, control algorithms and hardwired control systems are also fully covered so the resulting book is a comprehensive text and well suited to college courses or background reading for university students.

The text is supported by questions under the headings Keeping Up and Test Your Knowledge so that the reader can develop a sound understanding and the ability to apply the techniques they are learning.

228 pages

Order code NE35

£20.99

## HOW ELECTRONIC THINGS WORK – AND WHAT TO DO WHEN THEY DON'T Robert Goodman

You never again have to be flummoxed, flustered or taken for a ride by a piece of electronics equipment. With this fully illustrated, simple-to-use guide, you will get a grasp on the workings of the electronic world that surrounds you – and even learn to make your own repairs.

You don't need any technical experience. This book gives you: Clear explanations of how things work, written in everyday language. Easy-to-follow, illustrated instructions on using test equipment to diagnose problems. Guidelines to help you decide for or against professional repair. Tips on protecting your expensive equipment from lightning and other electrical damage. Lubrication and maintenance suggestions.

Covers: colour TVs, VCRs, radios, PCs, CD players, printers, telephones, monitors, camcorders, satellite dishes, and much more!

394 pages

Order code MGH3

£21.99

## VINTAGE RADIOS – COLLECTING ● SERVICING ● RESTORING Tony Thompson

The essential guide to collecting, repairing and restoring vintage valve radios. These receivers are becoming ever more popular as collectibles, this is a good thing because it means that a very large piece of technological history is being reclaimed when at one time many thought it lost forever. If you look around, you will find plenty of valve radio sets just waiting for a loving restoration. They may not yet be the most highly prized, and they are unlikely to be in top condition, but they can be yours and, if you develop the skills outlined in this book, you will possess radio receivers to be proud of.

The book covers radio history, styling, faultfinding, chassis and cabinet restoration, types of set.

124 pages spiral bound

Order code TT1

£13.50



All prices include UK P&P



# Project Building

## ELECTRONIC PROJECT BUILDING FOR BEGINNERS

R. A. Penfold

This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:

Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.

In fact everything you need to know in order to get started in this absorbing and creative hobby.

135 pages

Order code BP392

£5.49

## BUILDING VALVE AMPLIFIERS

Morgan Jones

The practical guide to building, modifying, fault-finding and repairing valve amplifiers. A hands-on approach to valve electronics – classic and modern – with a minimum of theory. Planning, fault-finding, and testing are each illustrated by step-by-step examples.

A unique hands-on guide for anyone working with valve (tube in USA) audio equipment – as an electronics experimenter, audiophile or audio engineer.

Particular attention has been paid to answering questions commonly asked by newcomers to the world of the vacuum tube, whether audio enthusiasts tackling their first build, or more experienced amplifier designers seeking to learn the ropes of working with valves. The practical side of this book is reinforced by numerous clear illustrations throughout.

368 pages

Order code NE40

£21.99

## Theory and Reference

## COIL DESIGN AND CONSTRUCTIONAL MANUAL

B. B. Babani

A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now twenty years old, with the exception of toroids and pulse transformers little has changed in coil design since it was written.

96 pages

Order code BP160

£4.49

## GETTING THE MOST FROM YOUR MULTIMETER

R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages

Temporarily out of print

## PRACTICAL ELECTRONIC FILTERS

Owen Bishop

This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.

The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rhythm sequencer and a multi-voiced electronic organ.

Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.

188 pages

Order code BP299

£5.49

## ELECTRONIC PROJECTS FOR EXPERIMENTERS

R. A. Penfold

Many electronic hobbyists who have been pursuing their hobby for a number of years seem to suffer from the dreaded "seen it all before" syndrome. This book is fairly and squarely aimed at sufferers of this complaint, plus any other electronics enthusiasts who yearn to try something a bit different.

The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.

138 pages

Order code BP371

£5.45

## PRACTICAL FIBRE-OPTIC PROJECTS

R. A. Penfold

While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.

The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.

All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.

132 pages

Order code BP374

£5.45

## ELECTRONIC MUSIC AND MIDI PROJECTS

R. A. Penfold

Whether you wish to save money, boldly go where no musician has gone before, rekindle the pioneering spirit,

or simply have fun building some electronic music gadgets, the designs featured in this book should suit your needs. The projects are all easy to build, and some are so simple that even complete beginners at electronic project construction can tackle them with ease. Stripboard layouts are provided for every project, together with a wiring diagram. The mechanical side of construction has largely been left to the individual constructors to sort out, simply because the vast majority of project builders prefer to do their own thing.

None of the designs requires the use of any test equipment in order to get them set up properly. Where any setting up is required, the procedures are very straightforward, and they are described in detail.

Projects covered: Simple MIDI tester, Message grabber, Byte grabber, THRU box, MIDI auto switcher, Auto/manual switcher, Manual switcher, MIDI patchbay, MIDI controlled switcher, MIDI lead tester, Program change pedal, Improved program change pedal, Basic mixer, Stereo mixer, Electronic swell pedal, Metronome, Analogue echo unit.

138 pages

Order code PC116

£5.45

## VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR

R. A. Penfold

Written by highly respected author R. A. Penfold, this book contains a collection of electronic projects specially designed for video enthusiasts. All the projects can be simply constructed, and most are suitable for the newcomer to project construction, as they are assembled on stripboard.

There are faders, wipers and effects units which will add sparkle and originality to your video recordings, an audio mixer and noise reducer to enhance your soundtracks and a basic computer control interface. Also, there's a useful selection on basic video production techniques to get you started.

Circuits include: video enhancer, improved video enhancer, video fader, horizontal wiper, improved video wiper, negative video unit, fade to grey unit, black and white keyer, vertical wiper, audio mixer, stereo headphone amplifier, dynamic noise reducer, automatic fader, pushbutton fader, computer control interface, 12 volt mains power supply.

124 pages

Order code PC115

£5.45

## BOOK ORDERING DETAILS

All prices include UK postage. For postage to Europe (air) and the rest of the world (surface) please add £2 per book. For the rest of the world airmail add £3 per book. CD-ROM prices include VAT and/or postage to anywhere in the world. Send a PO, cheque, international money order (£ sterling only) made payable to **Direct Book Service** or card details, Visa, Mastercard, Amex, Diners Club or Maestro to:

**DIRECT BOOK SERVICE, WIMBORNE PUBLISHING LTD.,  
408 WIMBORNE ROAD EAST, FERNDOWN, DORSET BH22 9ND.**

Books are normally sent within seven days of receipt of order, but please allow 28 days for delivery – more for overseas orders. *Please check price and availability (see latest issue of Everyday Practical Electronics) before ordering from old lists.*

For a further selection of books see the next two issues of **EPE**.

Tel 01202 873872 Fax 01202 874562. Email: [dbs@wimborne.co.uk](mailto:dbs@wimborne.co.uk)

Order from our online shop at: [www.epemag.co.uk](http://www.epemag.co.uk)

## BOOK ORDER FORM

Full name: .....

Address: .....

.....

.....

..... Post code: ..... Telephone No: .....

Signature: .....

☐ I enclose cheque/PO payable to DIRECT BOOK SERVICE for £ .....

☐ Please charge my card £ ..... Card expiry date.....

Card Number ..... Switch/Maestro Issue No.....

Card Security Code ..... (the last three digits on or just under the signature strip)

Please send book order codes: .....

.....

Please continue on separate sheet of paper if necessary  
If you do not wish to cut your magazine, send a letter or copy of this form

# PIC N' MIX

JOHN BECKER

Our periodic column for your PIC programming enlightenment

## Using a DS1267 dual digital potentiometer with a PIC

**T**HIS month and next we examine how a digital potentiometer chip can be interfaced to a PIC. The device chosen is the Maxim DS1267 dual digital potentiometer. This is available in three standard dual-in-line (d.i.l.) pinned versions, in which the two pots each have basic values of 100k (DS1267-100), or 50k (DS1267-50) or 10k (DS1267-10).

The one chosen by the author for use in a forthcoming design for *EPE* is the DS1267-100. For the sake of this demo, any of the three devices may be used.

The DS1267 consists of two digitally controlled solid-state pots. Each pot consists of 256 resistive sections. Between each section on both ends of the pot are tap points which are accessible to the wiper. The position of the wiper on the resistive array is set by an 8-bit value.

Control of the device is via a 3-wire serial interface. This interface allows the device wiper position to be written or read.

Both potentiometers can be connected in series or stacked for an increased total resistance with the same resolution. The DS1267 can be cascaded or daisy-chained. Its pinout diagram is shown in Fig.1 and the pin descriptions are given in Table 1.

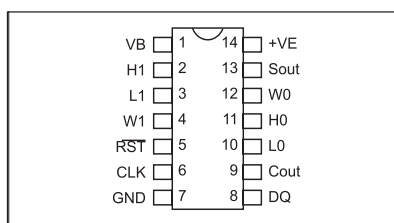


Fig.1. Pinouts for the DS1267

### Operation

The two 8-bit wiper values and the stack select bit are written to a 17-bit I/O (input/output) shift register. The register arrangement is shown in Fig.2.

The controlling serial interface consists of three input signals, RST, CLK and DQ.

The RST control line must be high to begin any communication with the

Table 1: DS1267 Pin Descriptions

L0, L1	low end of resistor
H0, H1	high end of resistor
W0, W1	wiper terminal of resistor
SOUT	stacked configuration output
RST	serial port reset input
DQ	serial port data input
CLK	serial port clock input
COU	cascade port output
+5V	+5V supply input (range 4.5V to 5.5V)
GND	ground (0V)
VB	substrate bias voltage (range -5.5V to 0V)

DS1267. The CLK line provides timing synchronisation for data input and output. The DQ line is used to transmit data to the 17-bit shift register.

The 3-wire protocol is illustrated in Fig.3a. As shown, the 3-wire port is inactive when the RST signal input is low. Communication via the port requires the RST input to be in a high state. Data is then entered into the device on the low to high transition of the CLK line. Basic timing is shown in Fig.3b.

It is worth noting that although timing notations are quoted in Fig.3b, and quantified in the full datasheet, the controlling PIC code shown in Listing 1 does not need these values to be actively considered. The demo software has been used successfully with a DS1267 and a PIC running at 10MHz.

### Shift Register

Data written to the DS1267 is stored in the 17-bit I/O shift register (Fig.2). Bit 0 of the register contains the stack select bit, discussed presently. Bits 1 to 8 contain the wiper position for pot 1. Bit 1 is the MSB and bit 8 is the LSB. Bits 9 to 16 contain the wiper position for pot 0, with bit 9 as the MSB and bit 16 as the LSB.

Data transmission always begins with the stack select bit, followed by the pot 1 and then pot 0 wiper positions. When wiper data is to be written to (or read from) the DS1267, 17 bits (or some

integer multiple) of data must always be transmitted. Transmissions which do not send a complete 17-bits (or multiple) will leave the register incomplete and possibly an error in the desired wiper positions.

After a transmission has been completed, the RST signal should be taken low again for the new wiper position to become valid. On device power-up, the wiper positions are set at 50% of the total resistance, or binary value 10000000 (decimal 128).

### Demo Program

The demo program, whose main code is shown in Listing 1, illustrates how data can be written to the pots. It was written for a PIC16F628, but can equally well be used with other PICs, such as the PIC16F8x and PIC16F87x families. All that is necessary is to change the PIC type references at the head of ASM code.

As written, the demo uses PIC pins RB0 to RB2, but other pins may be allocated instead. The connections between the DS1267 and the PIC are shown in Fig.4. The PIC may be run with any clock rate, crystal or RC controlled, with the configuration settings value amended to suit. The prototype was run at 4MHz, although the code has also been run on a 16F877 at 10MHz.

Note that if a -5V supply is not available, the -5V supply pin(s) may be connection to the 0V line.

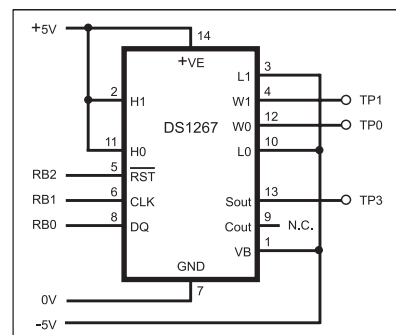


Fig.4. Demo connections

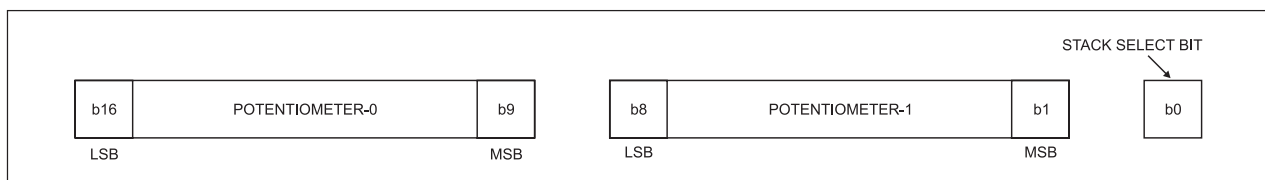


Fig.2. Internal register arrangement for the DS1267



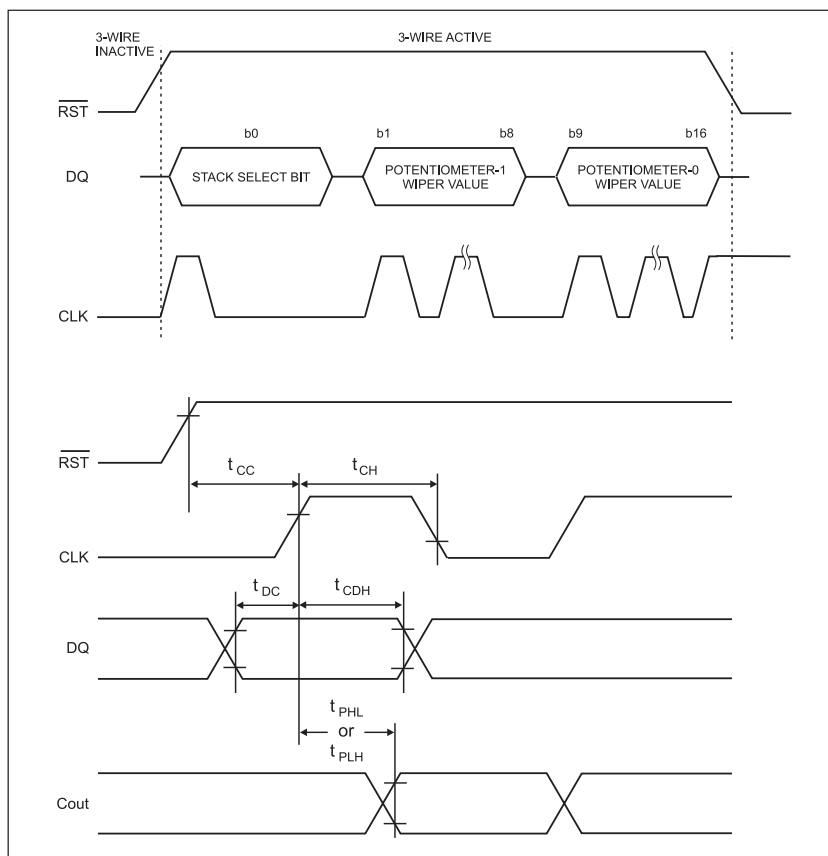


Fig.3. Control waveforms for the DS1267

#### LISTING 1. Demo Code

```

SETPOTS:  bsf PORTB,POTRST    ; set to dig pot to receive data
          bcf PORTB,POTDATA  ; clear stack bit
          call CLKPOT        ; send stack bit

          movf POTVAL1,W     ; send pot 1 val (chip 1)
          call POTOUT
          movf POTVAL0,W     ; send pot 0 val (chip 1)
          call POTOUT
          incf POTVAL0,F      ; inc pot 0 val
          decf POTVAL1,F      ; dec pot 1 val
          goto ENDPOT        ; delete this if sending to 2 digipot chips

          bcf PORTB,POTDATA  ; clear stack bit
          call CLKPOT        ; send stack bit
          movf POTVAL3,W     ; send pot 3 val (chip 2)
          call POTOUT
          movf POTVAL2,W     ; send pot 2 val (chip 2)
          call POTOUT
          movlw 3
          addwf POTVAL2,F
          movlw 5
          addwf POTVAL3,F

ENDPOT:   bcf PORTB,POTRST    ; disable dig pot from receiving data
          goto SETPOTS       ; repeat

POTOUT:   movwf STORE        ; copy W into STORE
          movlw 8             ; set loop for 8 actions
          movwf LOOP

DIGLOOP0: bcf PORTB,POTDATA  ; clear data bit
          rlf STORE,F         ; rotate store left (MSB out first)
          btfsc STATUS,C      ; is CARRY set?
          bsf PORTB,POTDATA  ; yes, set data bit
          call CLKPOT        ; send data bit
          decfsz LOOP,F       ; dec loop, is it 0?
          goto DIGLOOP0      ; no, repeat for next bit
          return

CLKPOT:   bsf PORTB,POTCLK    ; take dig pot clk high
          bcf PORTB,POTCLK    ; take dig pot clk low
          return

```

The code is essentially a loop in which different values are written cyclically to the DS1267 pots. When the outputs of the pot wipers are viewed on an oscilloscope, a falling sawtooth will be seen on wiper W0, and rising sawtooth on W1.

In Listing 1, the registers which hold the code to be written to the pots are named POTVAL0 and POTVAL1. In the PIC initialisation routine (not shown) they are first set to zero.

On entry to the routine starting at SETPOTS, the RST line is taken high, and the stack bit is cleared (**bcf PORTB,POTDATA**). The CLK line is then toggled up and down in sub-routine CLKPOT. This sets the stack bit into the DS1267 as bit b0.

Next POTVAL0's value is copied into W, the POTOUT routine is called, and the contents of W copied into STORE. A loop counter is now set for eight cycles. Within the loop the POTDATA bit is first cleared and the STORE register rotated left and into CARRY. If CARRY is set, so the POTDATA bit is also set. The CLK line is again toggled to send the data bit to the DS1267.

The loop counter is then decremented and, if not zero, the process is repeated for the next bit in STORE. When all eight bits have been sent (bits b1 to b8), a return from loop occurs. The process is then repeated for the POTVAL1 value (bits b9 to b16).

Following the return from this loop the POTVAL0 value is then incremented and POTVAL1 decremented. A jump is then made to ENDPOT, at which point the RST line is taken low, completing the sending of all 17 bits.

The data sending routine is then repeated by a jump back to label SETPOTS.

This continues indefinitely until the power is switched off. The result is the rising and falling ramp waveforms from the wipers as stated above.

The ten commands following **goto ENDPOT** will be discussed next month.

### Stack Waveform

The output at stack register pin SOUT depends on the value of the stack register bit (b0). If b0 = 0 then the waveform at SOUT is the same as that at wiper W0. With b1 = 1 then the output is the same as at W1. This can be proved by monitoring W0 and SOUT while the PIC holds the demo code as illustrated. Now, in the ASM code, amend the line:

```

bcf PORTB,POTDATA ; clear stack bit
to:
bsf PORTB,POTDATA ; set stack bit

```

Re-compile the code to HEX and send that to the PIC. Now monitor SOUT and W1 to prove that the waveform of W1 is now being output at SOUT.

### Resources

Software for this demo can be downloaded *free* from the *EPE* Downloads site, accessible via the home page at [www.epemag.co.uk](http://www.epemag.co.uk). It is held in the PICnMix folder, under PNMSEP05.

The complete datasheet for the DS1267 can be download from [www.maxim-ic.com](http://www.maxim-ic.com).

# Net Work

Alan Winstanley



## A Growing Band

In the UK, the number of broadband users has outstripped dial-up (narrowband) customers for the first time. Last month I described how – at last! – ADSL broadband suddenly arrived in my worklab after many years of frustration and eager anticipation. The service (Tiscali's 512k) is bearing up well, although there have been a few worries about the reliability of outbound email.

One practical problem relates to the conversion of the fax line for broadband. A microfilter is used to enable the fax machine – an unreliable HP 6110 all-in-one – to function on the broadband line. Annoyingly, some fax machines now have problems negotiating properly when trying to send a fax to the author, whilst other machines are perfectly fine. Talk about one step forward...

## Outward Bound

The other problem experienced after the broadband conversion has been the sending of email. This has proved somewhat unreliable at times, possibly due to maintenance or overloaded servers, but it has occasionally been a trial to send mails through Tiscali's outbound mailservers. Problems come and go in phases.

As regular *Net Work* readers will know, outgoing emails are usually handled by the ISP's own SMTP (Simple Mail Transfer Protocol) server. If this were not the case, then users could connect to the Internet through any ISP and then potentially burden another ISP's outgoing mail server with spam.

Other strange outbound mail problems can arise due to a number of reasons. BT's own Internet Service Provider has been known to cause erratic problems when trying to send mail under a user's own domain name. Outbound mails with a FROM: address of <me>@mydomain.co.uk may fail to be sent, and only by sending it as FROM:<username123>@btconnect.com (or similar) will mails be successfully transmitted.

In one case that the writer had to deal with, after a long spell without any problems at all, BT's broadband service suddenly blocked the transmission of a business customer's domain mail, and in a rather unusual move, BT validated the registration details of the said domain name by searching Nominet's database. BT is checking up on its customers. Not convinced by what they found, mail relaying is still denied by BT and the customer is still unable to send his own domain mail, effectively being treated as a serial spammer.

If your ISP does not allow outbound mail relaying then it will not be possible to use your domain name as a sender's address. Amongst other ISPs, Tiscali, Demon and Wanadoo (formerly Freeserve, and due to change its name to Orange) will all allow own domain mails to be sent successfully without problems.

AOL users who also have their own domain name have the same mail relaying problem:

only <screenname>@aol.co.uk/.com succeeds as a FROM: address. Incidentally, AOL users are not compelled to use AOL's proprietary email and browser programs. They can use Microsoft Outlook, Outlook Express, Eudora or other IMAP compatible software to handle emails, and can also fire up MSIE to surf the web after connecting to the net through AOL.

Other outbound mail problems suffered by the author include mail bouncing due to the temporary blacklisting of a Tiscali SMTP server, perhaps the after-effects of a spam campaign. The problem for the author, then, was to find an alternative and more reliable way of sending multiple domain emails that short-circuited Tiscali.

## ISP-Independent Mailing

This month I suggest a way in which outgoing emails can be sent regardless of which service provider is used to connect to the Internet. AuthSMTP ([www.authsmtp.net](http://www.authsmtp.net)) is a service designed specially for those who suffer SMTP problems with their ISP. Instead of using your ISP's server, send all outgoing mail through AuthSMTP instead. The cost of the service is trivial at entry level, just £14 or \$25 per year, allowing up to ten FROM: addresses and 1,000 mails/100MB of outbound mail per month. At the other end of the scale, for £4,505 or \$8,009 per year, you can send up to half a million emails per month, or 50GB worth.

After completing the online sign-up procedure, which includes a rigorous verification of email addresses, AuthSMTP was enabled, although there were initially some frustrating problems when trying to get the author's Eudora mail software to use AuthSMTP properly. These were eventually overcome and no such problems are anticipated with e.g. Microsoft Outlook.

The author has nothing but praise for the pre-sales and technical support supplied by AuthSMTP, who delivered very rapid responses even in the early hours of the morning.

Their SMTP service provides a very simple control panel that enables usage to be monitored or new addresses to be set up. All outbound email problems have been eliminated, and two months of testing have shown how AuthSMTP complements the broadband connection well, handling attachments and domain mail flawlessly. And remember that using AuthSMTP means that you can connect to the net using any ISP and simply configure your email program to send out via AuthSMTP. This

could be an ideal solution for many users that suffer problems sending mail, or even if you use a laptop around the country (world), you can fire all your email through the same SMTP server regardless of how you connect to the Internet. Users can sign up for a 14-day trial.

My thanks to reader *David Sims* who suggests a freeware program called Netmeter which helps you to gauge monthly usage. Similar to the DU Meter program I mentioned last month, you can download it from <http://readerror.gmxhome.de/>.

You can email me at [alan@epemag.demon.co.uk](mailto:alan@epemag.demon.co.uk).



*AuthSMTP is an independent SMTP server that may solve many problems with outgoing emails*

# PCB SERVICE

Printed circuit boards for most recent *EPE* constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, Everyday Practical Electronics, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872; Fax 01202 874562; Email: orders@epemag.wimborne.co.uk. On-line Shop: www.epemag.wimborne.co.uk/shopdoor.htm.** Cheques should be crossed and made payable to *Everyday Practical Electronics* (Payment in £ sterling only).

**NOTE:** While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Back numbers or photostats of articles are available if required – see the *Back Issues* page for details. We do not supply kits or components for our projects.

**Please check price and availability in the latest issue.**

**A large number of older boards are listed on our website.**

Boards can only be supplied on a payment with order basis.

PROJECT TITLE	Order Code	Cost
Infra-Guard <b>APR '04</b>	439	£5.07
★ Moon Clock	442	£5.71
★ Teach-In '04 Part 6 – Software only	–	–
★ EPE Seismograph Logger	–	–
Control Board	440	} pair £6.50
Sensor Amp. Board	441	
In-Car Lap-Top PSU <b>MAY '04</b>	443	£4.60
Beat Balance Metal Detector	444	£4.60
Teach-In '04 Part 7 – Transmitter	445	£4.91
Receiver	446	£4.75
Moisture	447	£4.44
★ PIC Quickstep <b>JUNE '04</b>	448	£5.71
Body Detector MkII	449	£4.91
★ Teach-In '04 Part 8 – Software only	–	–
★ MIDI Synchronome – Software only	–	–
Hard Drive Warbler <b>JULY '04</b>	450	£4.60
★ Bongo Box	451	£6.02
Portable Mini Alarm – Sensor	452	£5.23
– Counter	453	£5.07
★ Teach-In '04 Part 9	–	–
PIC Combination Lock Alarm Monitor	454	£5.07
★ EPE Magnetometry Logger	455	£5.71
Keyring L.E.D. Torch <b>AUG '04</b>	456	£4.12
★ Teach-In '04 Part 10 – PIC Curtain or Blind Winder	457	£5.39
Simple F.M. Radio – F.M. Tuner	458	£5.07
– Tone Control	459	£4.75
– Audio Power Amp (TDA2003)	347	£4.60
– Power Supply	460	£5.39
★ EPE Scorer	461	£6.66
– Control Board	462	£7.93
– Display Board	463	£5.55
– Slave Board	–	–
★ PIC to Mouse/Keyboard – Software only <b>SEPT '04</b>	464	£4.60
EPE Wart Zapper	465	£4.76
★ Radio Control Failsafe	466	£4.60
★ AlphaMouse Game	–	–
★ Rainbow Lighting Controller – Software only	–	–
★ Moon and Tide Clock Calendar <b>OCT '04</b>	467	£5.55
Volts Checker	468	£4.20
★ Smart Karts – Software only	–	–
Logic Probe <b>NOV '04</b>	469	£4.76
Thunderstorm Monitor	470	£5.39
MW Amplitude Modulator	–	–
– V.F.O./Buffer	471	£4.76
– Modulator/PA	472	£5.07
– Power Supply	473	£4.76
Super Vibration Switch <b>DEC '04</b>	474	£4.75
Wind Direction Indicator	475	£6.18
★ PIC Flasher Mk2 – Control Board	476	£4.75
– Transmitter	477	£4.44
– Multipurpose Board	478	£4.75
– Simple Cycler	479	£4.44
– Luxeon V Controller	480	£4.44
– Power Supply	473	£4.76
Light Detector <b>JAN '05</b>	481	£4.44
★ Camera Watch	482	£6.03
Gate Alarm – Oscillator	483	£4.92
– Delay/Timer	484	£4.92
★ Sneaky – Transmitter <b>FEB '05</b>	485	£4.60
– Receiver	486	£4.91
★ PIC Electric Mk2 – Control	487	£5.87
– Sensor	488	£5.71
Sound Card Mixer	489	£7.29
Headphone Monitor <b>MAR '05</b>	490	£5.71
EPE Cat Flap	491	£6.02
★ Bingo Box	492	£9.04
– Main	–	–
– Big Digit Display	493	£10.31
Spontaflex Radio– Tuner <b>APR '05</b>	494	£5.55
– Coil Pack	495	£5.71
– Audio Amplifier	496	£5.55
– Tuning Capacitor Board	406	£4.28
★ Safety Interface	497	£6.18
Back-To-Basics 1– Fridge/Freezer Door Alarm	498	£5.39

PROJECT TITLE	Order Code	Cost
★ Crossword Solver <b>MAY '05</b>	499	£6.66
20W Amplifier Module	500	£5.14
Back-To-Basics 2 – Water Level Alarm	501	£5.39
– Burglar Alarm	502	£5.87
★ PIC Ultrasonic Scanner <b>JUN '05</b>	503	£6.66
★ Radio Control Model Switcher	504	£5.87
Back-To-Basics 3 – Scarecrow	505	£5.55
– Digital Lock	506	£6.66
CompactFlash Interface Board	507	£6.66
LF/VLF Converter <b>JUL '05</b>	508	£5.71
– Fixed Capacitor Board	509	£5.86
– Mixer/Oscillator Board	510	£5.23
– Buffer Amplifier	511	£5.23
– Q-Multiplier	406	£4.28
– Tuning Capacitor Board	512	£6.34
Back-To-Basics 4 – Doorchime	513	£6.02
– Electronic Dice	514	£6.82
★ Cybervox	515	£6.66
Multi-Clap Switch <b>AUG '05</b>	516	£6.02
Audio System	517	£5.23
– Preamplifier	518	£6.02
– Mic. Supply Board	519	£7.14
– Power Amp	520	£7.45
★ Pain Monitor	521	£5.87
MotorAmp	522	£6.02
Back-To-Basics 5	523	£5.71
– Kitchen Timer	524	£5.23
– Room Thermometer	525	£6.19
All-Band Radio – Full Version <b>SEPT '05</b>	526	£5.55
– Mini Version	527	£6.19
Multicore Cable Tester – Main	528	£5.87
– Active	529	£6.19
Back-To-Basics 6 – Daily Reminder	530	£8.72
– Whistle Switch	–	–
★ Model Railway Signal Control	–	–
★ Snooker/Darts Scoreboard	–	–

## EPE SOFTWARE

Software programs for *EPE* projects marked with a single asterisk ★ are available on 3.5 inch PC-compatible disks or **free** from our Internet site. The following disks are available: **PIC Tutorial V2** (Apr-June '03); **EPE Disk 3** (2000); **EPE Disk 4** (2001 – excl. PIC Toolkit TK3); **EPE Disk 5** (2002); **EPE Disk 6** (2003 – excl. Earth Resistivity and Met Office); **EPE Disk 7** (2004); **EPE Disk 8** (Jan 2005 to current cover date); **EPE Earth Resistivity Logger** (Apr-May '03); **EPE PIC Met Office** (Aug-Sept '03); **EPE Seismograph** (Apr-May '04); **EPE Magnetometry Logger** (July-Aug '04); **EPE Teach-In 2000**; **EPE Spectrum**; **EPE Interface Disk 1** (October '00 issue to current cover date). **EPE Toolkit TK3** software is available on the *EPE* PIC Resources CD-ROM, £14.45. Its p.c.b. is order code 319, £8.24. ★★ The software for these projects is on its own CD-ROM. The 3.5 inch disks are £3.00 each (UK), the CD-ROMs are £6.95 (UK). Add 50p each for overseas surface mail, and £1 each for airmail. All are available from the *EPE PCB Service*. All files can be downloaded **free** from our Internet FTP site, accessible via our home page at: [www.epemag.co.uk](http://www.epemag.co.uk).

## EPE PRINTED CIRCUIT BOARD SERVICE

Order Code	Project	Quantity	Price
Name .....			
Address .....			
Tel. No. ....			
I enclose payment of £..... (cheque/PO in £ sterling only) to:			
<div>       </div>			
Card No. ....			
Valid From .....		Expiry Date .....	
Card Security Code .....		Switch/Maestro Issue No .....	
(The last 3 digits on or just under the signature strip)			
Signature .....			
<p><b>NOTE:</b> You can also order p.c.b.s by phone, Fax, Email or via our Internet site on a secure server:</p> <p><a href="http://www.epemag.wimborne.co.uk/shopdoor.htm">http://www.epemag.wimborne.co.uk/shopdoor.htm</a></p>			



We can supply back issues of *EPE* by post, most issues from the past three years are available. An *EPE* index for the last five years is also available at [www.epemag.co.uk](http://www.epemag.co.uk) or see order form below. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photocopy of any *one article* (or *one part* of a series) can be purchased for the same price. Issues from Nov. 98 are available on CD-ROM – see next page – and issues from the last six months are also available to download from [www.epemag.com](http://www.epemag.com).

Please make sure all components are still available before commencing any project from a back-dated issue.

## DID YOU MISS THESE?

### MAY '04

**PROJECTS** • Beat Balance Metal Detector • In-Car Laptop PSU • Low-Frequency Wien Oscillator • EPE Experimental Seismograph Logger-2.  
**FEATURES** • Coping With Lead-Free Solder • Teach-In 2004 – Part 7 • Ingenuity Unlimited • Techno Talk • Circuit Surgery • Practically Speaking • Pic-N'-Mix • Net Work – The Internet Page.

### JUNE '04

#### Photocopies only

**PROJECTS** • PIC Quickstep • Crafty Cooling • MIDI Synchronome • Body Detector Mk2.  
**FEATURES** • Clinical Electrotherapy • Ingenuity Unlimited • Teach-In 2004 – Part 8 • Interface • Circuit Surgery • Techno Talk • PIC-N'-Mix • Net Work – The Internet Page.

### JULY '04

#### Photocopies only

**PROJECTS** • Portable Mini Alarm • Bongo Box • Hard Drive Warbler • EPE PIC Magnetometry Logger-1.  
**FEATURES** • Making Front Panel Overlays • Practically Speaking • Teach-In 2004 – Part 9 • Ingenuity Unlimited • Circuit Surgery • Techno Talk • PIC-N'-Mix • Net Work – The Internet Page.



### AUG '04

**PROJECTS** • EPE Scorer • Keyring L.E.D. Torch • Simple F.M. Radio • EPE PIC Magnetometry Logger – 2.  
**FEATURES** • PIC To PS/2 Mouse and Keyboard Interfacing • Techno Talk • Circuit Surgery • Teach-In 2004 – Part 10 • Interface • Ingenuity Unlimited • PIC-N'-Mix • Net Work – The Internet Page.

### SEPT '04

**PROJECTS** • EPE Wart Zapper • Radio Control Failsafe • Rainbow Lighting Control • Alphamouse Game.  
**FEATURES** • Light Emitting Diodes – Part 1 • High Speed Binary-To-Decimal For PICs • Practically Speaking • Ingenuity Unlimited • Techno Talk • Circuit Surgery • PIC-N'-Mix • Network – The Internet Page.

### OCT '04

#### Photocopies only

**PROJECTS** • EPE Theremin • Smart Karts – Part 1 • Volts Checker • Moon and Tide Clock Calendar.  
**FEATURES** • Light Emitting Diodes – 2 • Circuit Surgery • Interface • Ingenuity Unlimited • Techno Talk • PIC-N'-Mix • Network – The Internet Page • ROBOTS – Special Supplement

### NOV '04

**PROJECTS** • Thunderstorm Monitor • M.W. Amplitude Modulator • Logic Probe • Smart Karts - 2.  
**FEATURES** • Light Emitting Diodes-3 • Floating Point Maths for PICs • Ingenuity Unlimited • PE 40th Anniversary • Circuit Surgery • Techno Talk • PIC-N'-Mix • Net Work – The Internet Page.

### DEC '04

#### Photocopies only

**PROJECTS** • Super Vibration Switch • Versatile PIC Flasher • Wind Direction Indicator • Smart Karts - 3.  
**FEATURES** • Light Emitting Diodes-4 • Ingenuity Unlimited • Circuit Surgery • Interface • PIC 'N' Mix • Techno Talk • Net Work – The Internet Page • INDEX Vol. 33.



### JAN '05

**PROJECTS** • Speed Camera Watch • Gate Alarm • Light Detector • Smart Karts - 4.  
**FEATURES** • Practically Speaking • 32-Bit Signed Integer Maths for PICs • Ingenuity Unlimited • Circuit Surgery • Techno Talk • PIC 'N' Mix • Picoscope 3205 Review • Net Work – The Internet Page

### FEB '05

**PROJECTS** • PIC Electric Mk2 Pt1 • Sneaky • Sound Card Mixer • Smart Karts - 5.  
**FEATURES** • Interface • Circuit Surgery • Ingenuity Unlimited • Techno Talk • PIC 'N' Mix • E-Blocks and Flowcode V2.0 Reviews • Net Work – The Internet Page

### MAR '05

**PROJECTS** • Cat Flap • Stereo Headphone Monitor • PIC Electric Mk2 Pt2 • Smart Karts - 6 • Bingo Box.  
**FEATURES** • TK3 Simulator and PIC18F Upgrade • Circuit Surgery • Ingenuity Unlimited • Techno Talk • PIC 'N' Mix • Practically Speaking • Net Work – The Internet Page

### APR '05

**PROJECTS** • Spontaflex Radio Receiver • Safety Interface • Fridge/Freezer Door Alarm • Smart Karts - 7.  
**FEATURES** • Back To Logic Basics - 1 • Circuit Surgery • Ingenuity Unlimited • Interface • PIC18F Microcontroller Family Introduction • Techno Talk • Net Work – The Internet Page

### MAY '05

**PROJECTS** • Crossword Solver • DAB Radio Aerial • 20W Amplifier Module • Smart Karts - 8 • Water Level Detector • Burglar Alarm  
**FEATURES** • Back To Logic Basics - 2 • Circuit Surgery • Ingenuity Unlimited • Passive Component Testing • Practically Speaking • Techno Talk • Net Work – The Internet Page

### JUNE '05

**PROJECTS** • PIC Ultrasonic Radar • Radio Control Model Switcher • Super-Ear Audio Telescope • Electronic Scarecrow • Digital Lock  
**FEATURES** • Catch the Wave (Tsunami) • Back To Basics – 3 • Digital TV Switchover • Programming PIC 18F Interrupts • Circuit Surgery • Interface • Ingenuity Unlimited • Net Work – The Internet Page



### JULY '05

**PROJECTS** • Cybervox • LF and VLF Converter • Multi-Clap Switch • Doorchime • Electronic Dice  
**FEATURES** • Discovering PICs Reviewed • Back To Basics – 4 • Digital TV Switchover • Practically Speaking • Circuit Surgery • Interface – The Internet Page

### AUG '05

**PROJECTS** • Motor Amplifier • Pain Monitor • Audio System-Communications • Kitchen Timer • Room Thermometer  
**FEATURES** • Back To Basics – 5 • Circuit Surgery • Interface • Ingenuity Unlimited • Techno Talk • PIC 'N' Mix • NetWork – The Internet Page

## BACK ISSUES ONLY £3.80 each inc. UK p&p.

Overseas prices £4.50 each surface mail, £5.50 each airmail.

We can also supply issues from earlier years: 2000 (except Feb., Mar., July, Oct.), 2001 (except Feb., May, Aug., to Nov.), 2002 (except Feb., June, Aug. to Nov.), 2003 (except June), 2004 (except June, July, Oct. and Dec). Where we do not have an issue a photocopy of any *one article* or *one part* of a series can be provided at the same price.

### ORDER FORM – BACK ISSUES – PHOTOCOPIES– INDEXES

- ☐ Send back issues dated .....  
☐ Send photocopies of (article title and issue date) .....  
☐ Send copies of last five years indexes (£3.80 for five inc. p&p – Overseas £4.50 surface, £5.50 airmail)

Name .....

Address .....

Tel: .....

☐ I enclose cheque/P.O./bank draft to the value of £ .....

☐ Please charge my Visa/Mastercard/Amex/Diners Club/Switch £ .....

Card No. .... Switch Issue No .....

Valid From ..... Card Expiry Date ..... Card Security Code .....

(The last 3 digits on or just under the signature strip)

SEND TO: Everyday Practical Electronics, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND.

Tel: 01202 873872. Fax: 01202 874562.

E-mail: [orders@epemag.wimborne.co.uk](mailto:orders@epemag.wimborne.co.uk) On-line Shop: [www.epemag.wimborne.co.uk/shopdoor.htm](http://www.epemag.wimborne.co.uk/shopdoor.htm)

Payments must be in £ sterling – cheque or bank draft drawn on a UK bank. Normally supplied within seven days of receipt of order.  
Send a copy of this form, or order by letter if you do not wish to cut your issue.

MOS/05

Everyday Practical Electronics reaches twice as many UK readers as any other UK monthly hobby electronics magazine, our sales figures prove it. We have been the leading monthly magazine in this market for the last twenty years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £10 (+VAT) per single column centimetre (minimum 2.5cm). The prepaid rate for classified adverts is 40p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Phone: 01202 873872. Fax: 01202 874562. Email: [epreads@wimborne.co.uk](mailto:epreads@wimborne.co.uk)

For rates and information on display and classified advertising please contact our Advertisement Manager, Stewart Kearn as above.

## TOTALROBOTS

### ROBOTICS, CONTROL & ELECTRONICS TECHNOLOGY

High quality robot kits and components  
UK distributor of the OOPic microcontroller

Secure on-line ordering  
Rapid delivery  
Highly competitive prices

Visit [www.totalrobots.com](http://www.totalrobots.com)

**Tel: 01737 371688**

### The Versatile, Programmable On Screen Display System [www.STV5730A.co.uk](http://www.STV5730A.co.uk)



- Fully programmable
- PIC 16F628 microcontroller
- Demo software code available
- OSD IC 28 by 11 screen
- I/O lines free to connect sensors or buttons
- Serial or PC keyboard interface versions

TEXT, GPS or DATA

## VVTRANSFORMERS

Transformers and Chokes for all types of circuits including specialist valve units  
Custom design or standard range  
High and low voltage

### Variable Voltage Technology Ltd

Unit 3, Sheat Manor Farm, Chillerton,  
Newport, Isle of Wight, PO30 3HP  
Tel: 0870 243 0414 Fax: 01983 721572  
email: [sales@vvt-cowes.freemove.co.uk](mailto:sales@vvt-cowes.freemove.co.uk)

[www.vvttransformers.co.uk](http://www.vvttransformers.co.uk)

### Miscellaneous

**MAKE YOUR HOBBY PAY.** Assemble units for the partially sighted. Local customers, sole area, instruction manual, material supplies and completed units supplied. Details: 02392 830158

**VALVES AND ALLIED COMPONENTS IN STOCK.** Phone for free list. Valves, books and magazines wanted. Geoff Davies (Radio), tel. 01788 574774.

**FREE! PROTOTYPE PRINTED CIRCUIT BOARDS!** Free prototype p.c.b. with quantity orders. Call Patrick on 028 9073 8897 for details. Agar Circuits, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast BT5 4GX.

**PRINTED CIRCUIT BOARDS - QUICK SERVICE.** Prototype and production artwork raised from magazines or draft designs at low cost. PCBs designed from schematics. Production assembly, wiring and software programming. For details contact Patrick at Agar Circuits, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast BT5 4GX. Phone 028 9073 8897, Fax 028 9073 1802, Email [agar@argonet.co.uk](mailto:agar@argonet.co.uk)

**WANTED URGENTLY**  
Old half inch ferrite rods. Must be half inch diameter and be six inches long or more. Will pay very good money for the rods. Contact Peter Tankard on Tel 0114 2316321 between 9am and 10pm.

**½ PRICE VALVES AND RADIO & ELECTRONIC COMPONENTS**  
Catalogues available for £1 refundable on 1st order. Over 1480 different valves and over 500 radio/electronic components.  
**W. Burcher, 676 Foxhall Road, Ipswich, Suffolk, IP3 8NQ. TEL: 01473 272218**

**NARROW BANDWIDTH TELEVISION ASSOCIATION.** Build your own television cameras and display units. Ring 0115 9282896 for leaflet or visit [www.nbtv.org](http://www.nbtv.org)

**KITS, TOOLS, COMPONENTS. S.A.E. catalogue.** SIR-KIT ELECTRONICS, 52 Severn Road, Clacton, CO15 3RB.  
[www.geocities.com/sirkitut](http://www.geocities.com/sirkitut)

## X-10® Home Automation We put you in control™

**Why tolerate when you can automate?**  
An extensive range of 230V X-10 products and starter kits available. Uses proven Power Line Carrier technology, no wires required.

Products Catalogue available Online.

Worldwide delivery.

### Laser Business Systems Ltd.



E-Mail: [info@laser.com](mailto:info@laser.com)

<http://www.laser.com>

Tel: (020) 8441 9788

Fax: (020) 8449 0430



## ByVac

**Microcontroller**  
Microcontroller kits, 8052 core, no development tools needed, runs BASIC in firmware, I2C, LCD and Infrared drivers built in. Program in BASIC and then run stand alone. Prices from £14.95 + P & P  
[www.byvac.com](http://www.byvac.com)



## [www.pawbooks.co.uk](http://www.pawbooks.co.uk)

Using ICs. Pinout diagrams.  
Numeric control.

Interactive Demonstrations.

Write, save, load your own programs.  
See ICs working on screen.

## BOWOOD ELECTRONICS LTD

Suppliers of Electronic Components

Place a secure order on our website or call our sales line  
All major credit cards accepted

Web: [www.bowood-electronics.co.uk](http://www.bowood-electronics.co.uk)

Unit 1, McGregor's Way, Turnoaks Business Park,  
Chesterfield, S40 2WB. Sales: 01246 200222

Send 60p stamp for catalogue

## Improve your memory !

Learn how to use digital memory cards in your design with our new

## SD and MMC card development kit

Please look on the 'Products' page at  
[www.alt-d.co.uk](http://www.alt-d.co.uk)

### N.R. BARDWELL LTD

ELECTRONIC COMPONENT SUPPLIES  
Stock of I.e.d.s, Semiconductors, Resistors, Capacitors and many more items.  
Send 44p for lists or visit our secure online ordering of [www.bardwells.co.uk](http://www.bardwells.co.uk)  
288, Abbeydale Road, Sheffield. S7 1FL  
Email - [sales@bardwells.co.uk](mailto:sales@bardwells.co.uk)

## BTEC ELECTRONICS TECHNICIAN TRAINING

NATIONAL ELECTRONICS  
VCE ADVANCED ICT  
HNC AND HND ELECTRONICS  
FOUNDATION DEGREES  
NVQ ENGINEERING AND IT  
DESIGN AND TECHNOLOGY

LONDON ELECTRONICS COLLEGE  
20 PENYVERN ROAD  
EARLS COURT, LONDON SW5 9SU  
TEL: (020) 7373 8721  
[www.lec.org.uk](http://www.lec.org.uk)



## Rechargeable Batteries With Solder Tags

### NIMH

AA 2000mAh .....	£2.82
C 4Ah .....	£4.70
D 9Ah .....	£7.60
PP3 150mAh .....	£4.95

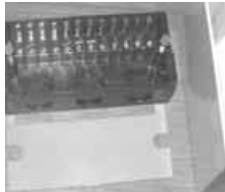
### NICAD

AA 650mAh .....	£1.41
C 2.5Ah .....	£3.60
D 4Ah .....	£4.95

### Instrument case with edge connector and screw terminals

Size 112mm x 52mm x 105mm tall

This box consists of a cream base with a PCB slot, a cover plate to protect your circuit, a black lid with a 12 way edge connector and 12 screw terminals built in (8mm pitch) and 2 screws to hold the lid on. The cream bases have minor marks from dust and handling price £2.00 + VAT(=£2.35) for a sample or £44.00+VAT(=£51.70) for a box of 44.



866 battery pack originally intended to be used with an orbitel mobile telephone it contains 10 1.6Ah sub C batteries (42 x 22 dia. the size usually used in cordless screwdrivers etc.) the pack is new and unused and can be broken open quite easily £7.46 + VAT = **£8.77**



Please add £1.66 + VAT = £1.95 postage & packing per order

## JPG Electronics

Shaws Row, Old Road, Chesterfield, S40 2RB.

Tel 01246 211202 Fax 01246 550959

www.JPGElectronics.com

Mastercard/Visa/Switch

Callers welcome 9.30 a.m. to 5.30 p.m. Monday to Saturday

## SHERWOOD ELECTRONICS

### FREE COMPONENTS

Buy 10 x £1 Special Packs and choose another one FREE

SP1 15 x 5mm Red LEDs	SP135 5 x Miniature slide switches
SP2 12 x 5mm Green LEDs	SP136 3 x BFY50 transistors
SP3 12 x 5mm Yellow LEDs	SP137 4 x W005 1.5A bridge rectifiers
SP4 25 x 5mm 1 part LED clips	SP138 20 x 2.2/63V radial elect. caps.
SP6 15 x 3mm Red LEDs	SP140 3 x W04 1.5A bridge rectifiers
SP7 12 x 3mm Green LEDs	SP142 2 x CMOS 4017
SP8 10 x 3mm Yellow LEDs	SP143 5 Pairs min. crocodile clips (Red & Black)
SP9 25 x 3mm 1 part LED clips	SP144 5 Pairs min.crocodile clips (assorted colours)
SP10 100 x 1N4148 diodes	SP146 10 x 2N3704 transistors
SP11 30 x 1N4001 diodes	SP147 5 x Stripboard 9 strips x 25 holes
SP12 30 x 1N4002 diodes	SP151 4 x 8mm Red LEDs
SP18 20 x BC182 transistors	SP152 4 x 8mm Green LEDs
SP20 20 x BC184 transistors	SP153 4 x 8mm Yellow LEDs
SP23 20 x BC549 transistors	SP154 15 x BC548 transistors
SP24 4 x CMOS 4001	SP156 3 x Stripboard, 14 strips x 27 holes
SP25 4 x 555 timers	SP160 10 x 2N3904 transistors
SP26 4 x 741 Op.Amps	SP161 10 x 2N3906 transistors
SP28 4 x CMOS 4011	SP162 2 x C106D thyristors
SP29 3 x CMOS 4013	SP165 2 x LF351 Op.Amps
SP33 4 x CMOS 4081	SP166 20 x 1N4003 diodes
SP34 20 x 1N914 diodes	SP167 5 x BC107 transistors
SP36 25 x 10/25V radial elect. caps.	SP168 5 x C108 transistors
SP37 12 x 100/35V radial elect. caps.	SP171 8 Metres 18SWG solder
SP38 15 x 47/25V radial elect caps	SP172 4 x Standard slide switches
SP39 10 x 470/16V radial elect. caps.	SP173 10 x 220/25V radial elect. caps
SP40 15 x BC237 transistors	SP174 20 x 22/25V radial elect. caps
SP41 20 x Mixed transistors	SP175 20 x 1/63V radial elect. caps.
SP42 200 x Mixed 0.25W C.F. resistors	SP177 10 x 1A 20mm quick blow fuses
SP47 5 x Min. PB switches	SP178 10 x 2A 20mm quick blow fuses
SP49 4 x 5 metres stranded core wire	SP181 5 x Phono plugs - assdtd couplers
SP101 8 Metres 22SWG solder	SP182 20 x 47/63V radial elect. caps.
SP102 20 x 8-pin DIL sockets	SP183 20 x BC547 transistors
SP103 15 x 14-pin DIL sockets	SP187 15 x BC239 transistors
SP104 15 x 16-pin DIL sockets	SP189 4 x 5 metres solid core wire
SP105 4 x 74LS00	SP192 3 x CMOS 4066
SP109 15 x BC557 transistors	SP195 3 x 10mm Yellow LEDs
SP112 4 x CMOS 4093	SP197 6 x 20 pin DIL sockets
SP115 3 x 10mm Red LEDs	SP198 5 x 24 pin DIL sockets
SP116 3 x 10mm Green LEDs	SP199 5 x 2.5mm mono jack plugs
SP118 2 x CMOS 4047	SP200 5 x 2.5mm mono jack sockets
SP124 20 x Assorted ceramic disc caps	
SP126 6 x Battery clips - 3 ea. PP3 + PP9	
SP130 100 x Mixed 0.5W C.F. resistors	
SP131 2 x TL071 Op.Amps	
SP133 20 x 1N4004 diodes	
SP134 15 x 1N4007 diodes	

### RESISTOR PACKS - C.Film

RP3 5 each value - total 365 0.25W	£3.30
RP7 10 each value - total 730 0.25W	£4.55
RP10 1000 popular values 0.25W	£6.45
RP4 5 each value-total 345 0.5W	£4.20
RP8 10 each value-total 690 0.5W	£6.85
RP11 1000 popular values 0.5W	£8.70

**2005 Catalogue available £1 inc. P&P or FREE with first order. P&P £1.50 per order. NO VAT**  
**Cheques and Postal Orders to:**  
**Sherwood Electronics,**  
**7 Williamson St., Mansfield,**  
**Notts. NG19 6TD.**

## ADVERTISERS INDEX

AUDON ELECTRONICS .....	.641
AVIT RESEARCH .....	.641
BETA-LAYOUT .....	.624
BITZ TECHNOLOGY .....	.632
BREADBOARDING .....	.633
BULL GROUP .....	Cover (ii)
CONRAD ELECTRONICS .....	.625
DISPLAY ELECTRONICS .....	.599
DUNLAOGHAIRE COLLEGE .....	.632
EASYSYNC .....	.624
ESR ELECTRONIC COMPONENTS .....	.602
FAST COMPONENTS .....	.599
FOREST ELECTRONIC DEVELOPMENTS .....	.594
JAYCAR ELECTRONICS .....	Cover (iv)
JPG ELECTRONICS .....	.664
LABCENTER .....	Cover (iii)
MAGENTA ELECTRONICS .....	.600/601
MICROCHIP TECHNOLOGY INC. ....	.621
NURVE NETWORKS LLC .....	.654
PEAK ELECTRONIC DESIGN .....	.644
PICO TECHNOLOGY .....	.641
QUASAR ELECTRONICS .....	.596/597
RD RESEARCH .....	.609
SHERWOOD ELECTRONICS .....	.664
STEWART OF READING .....	.599

### ADVERTISEMENT OFFICES:

408 WIMBORNE ROAD EAST, FERNDOWN, DORSET BH22 9ND

PHONE: 01202 873872

FAX: 01202 874562

EMAIL: epeads@wimborne.co.uk

For Editorial address and phone numbers see page 603

## EPE SUBSCRIPTIONS

**SAVE 71p AN ISSUE OVER UK NEWSTAND PRICES**  
**ON A UK ONE YEAR SUBSCRIPTION**

Subscriptions for delivery direct to any address in the UK: 6 months £16.50, 12 months £31, two years £57; Overseas: 6 months £19.50 standard air service or £28.50 express airmail, 12 months £37 standard air service or £55 express airmail, 24 months £69 standard air service or £105 express airmail. Cheques or bank drafts (in **£ sterling only**) payable to *Everyday Practical Electronics* and sent to *EPE Subs. Dept.*, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872. Fax: 01202 874562. Email: subs@epemag.wimborne.co.uk. Also via the **Web** at <http://www.epemag.wimborne.co.uk>. Subscriptions start with the next available issue. We accept MasterCard, Amex, Diners Club, Switch or Visa. (For past issues see the Back Issues page.)

## ONLINE SUBSCRIPTIONS

Online subscriptions, for downloading the magazine via the Internet, \$14.99US (approx. £8) for one year available from [www.epemag.com](http://www.epemag.com).

## USA/CANADA SUBSCRIPTIONS

To subscribe to *EPE* from the USA or Canada please telephone Express Mag toll free on 1877 363-1310 and have your credit card details ready. Or fax (514) 355 3332 or write to Express Mag, PO Box 2769, Plattsburgh, NY 12901-0239 or Express Mag, 8155 Larrey Street, Anjou, Quebec, H1J 2L5. Email address: [expsmag@expressmag.com](mailto:expsmag@expressmag.com).

**Web site: [www.expressmag.com](http://www.expressmag.com).**

USA price \$60(US) per annum, Canada price \$97(Can) per annum - 12 issues per year.

*Everyday Practical Electronics*, periodicals pending, ISSN 0262 3617 is published twelve times a year by Wimborne Publishing Ltd., USA agent USACAN at 1320 Route 9, Champlain, NY 12919. Subscription price in US \$60(US) per annum. Periodicals postage paid at Champlain NY and at additional mailing offices. POSTMASTER: Send USA and Canada address changes to *Everyday Practical Electronics*, c/o Express Mag., PO Box 2769, Plattsburgh, NY, USA 12901-0239.